SECTION 7:

# TECHNICAL SPECIFICATIONS

Specifications as per relevant IS codes and Bill of Quantities

# Works Requirements

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**Scope of Works**.....

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# Technical Specifications

## I General

### 1.1 Scope of Works

The scope of work under this contract shall include but not limited to the following and as specified in Bill of Quantities

**1.1.1** Scope of work as per the Schedule B of this tender

1.1.2 Providing and construction of wire cut brick Machinehole chambers , dismantling the damaged or collapsed machinehole and constructing of brick masonry chamber

1.1.3 Dismantling and reconstruction of of structures such as culverts , storm water drains, roads etc, and utility lines such as water supply lines , sewer lines coming in the way of pipeline alignment .

1.1.4 Backfilling the trenches , restoring and making good all surfaces which are damaged during the excavation.

1.1.5 Testing and commissioning of pipeline after laying.

1.1.6 Maintenance of all the pipelines for **12 months** after commissioning. During this period, the contractor has to set right the defect of any kind in the manufacture, laying and jointing of all the pipelines and in the other works in this scope of tender.

1.1.7 All work shall be done as per the specifications. The works shall include providing all materials, equipments, labour, tools, plants, transport etc., and all other services necessary for the complete construction including necessary sub-soil investigations.

## 1.2 Royalties

1.2.1 The Employer shall deduct Royalties on materials used in the Works from the progress payments to the Contractor at the rates specified in the most recent “Amendment to the Karnataka Minor Minerals Concession Rules - 1969” as published by the Commerce and Industries Department (Mines) and as illustrated in Annexure-1, attached.

## 1.3 Site Order Book

1.3.1 The Contractor shall maintain an identical pair of Site Order Books (one marked original and the other marked duplicate), at the Site at all times during the execution of the Works for the use of the Engineer and the Contractor. All instructions issued by the Engineer to the Contractor shall be recorded in both sets of the Site Order Book and shall be signed by the issuer and countersigned by the Contractor. After compliance with the instruction, the Contractor shall record the same in both sets of the Site Order Book duly signed and countersigned by the Engineer. Acceptance of any part of the work executed by the Contractor shall be subject to verification with respect to compliance of respective instructions of the Engineer through the Site Order Book. The Engineer shall retain the original copy of the Site Order Book, while the Contractor shall retain the duplicate one.

## 1.4 Quarry Materials

1.4.1 The Contractor shall be wholly responsible to identify the suitable sources for quarry materials required for the Works, such as earth, sand, stone, muram, etc., and to make his own arrangements for collection and transportation of the materials irrespective of the leads and lifts required. The quarry thus identified by the Contractor should have proper license from the Government of Karnataka. All materials supplied by the Contractor shall satisfy the requirements set forth in the Specifications and shall be subject to the approval of the Engineer. The Contractor shall take this into account while offering his rates and no claims whatsoever shall be entertained for extra costs on this account.

## 1.5 Inspection and testing

1.5.1Inspection of Material to be procured

Inspection and certification of all materials used on the works such as DWC pipes , PVC pipes for conformity with specifications of BIS. If insisted, inspection of materials at the manufacture place shall be arranged by the contractor at his cost including the travelling and accommodation of the inspecting officer.

1.5.2**Inspection and certification of the various components of works.**

Construction of DWC pipeline with all fixtures, construction of machinehole and brick masonry Chamber including back filling of trench in layers with compaction as specified to ensure that all components of works are carried out as per specification and to required standards.

Inspection & Certification of Hydraulic Test on Completed pipe line in reaches as specified.

## 1.6 Technical Specifications

1.6.1 Engineer shall have the right to modify/alter the Particular Specifications and/or Standard Specifications at any time which promise to confer equal or better quality than the standard specified in the tender document. Such modification or alteration shall be acceptable to the Contractor subject to no additional financial burden to either the Contractor or the Employer.

## 1.7 Storage of Materials and Plant

1.7.1 The Contractor shall provide appropriate storage facilities for materials like cement, steel, aggregates, consumable supplies, equipment, mechanical and electrical items, etc., and shall take all safety and security measures against theft and deterioration in quality, at his own cost.

## 1.8 Procurement of Materials:

1.8.1 CEMENT:

The Contractor shall use only 43 grade cement conforming to IS 8112 / 89 with latest amendments with ISI mark. The Contractor should furnish the manufacturer test certificate for the above brand of cement for having manufactured the cement as per relevant BIS and guarantee certificate before using the cement.

1.8.2 STEEL:

The Contractor shall procure the steel from VISL / SAIL / VSP / TISCO and manufacturers' test certificate is to be produced.

**1.8.3**. **Glazed Stone Ware Pipes , and others:** Any reputed make approved by BWSSB by producing the credentials.

**1.9 Equivalency of Standards and** be procured, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards which ensure an equal or higher quality

than the standards and codes specified will be acceptable subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.

**2 1.10 Sign Board**

3 1.10.1 The Contractor shall provide a sign board at the site of the Works of approved size and design which provides (i) the name of the Project (ii) the names and addresses of the Employer, the Contractor and the Consultant; (iii) the name and short description of the Project, (iv) the amount of the Contract Price ; and (v) the starting and completion dates.

**4 1.11 Samples and Tests**

5 1.11.1 The Contractor shall be responsible to develop a quality control program and to provide all necessary materials, apparatus, instruments, equipment, facilities and qualified staff for sampling, testing and quality control of the materials and the works under the Contract. Without limiting the generality of the foregoing, the Contractor shall either (i) establish a testing laboratory at the site of Works which is adequately equipped and staffed to carry out all sampling and testing in accordance with the requirement set out in the General Specifications and/or these Special Specifications and provide all field equipment and apparatus as necessary to conduct all specified in-situ tests and/or any Tests on Completion, provided the correctness of the equipments are ensured or (ii) arrange for routine sampling, testing and reporting, as required, through a certified independent testing laboratory acceptable to the Engineer. All costs of such sampling, testing and reporting of test results will be borne by the Contractor, and the Contractor shall include sufficient provisions in his tendered rates to allow for independent sampling and laboratory testing under the direction of the Engineer up to 5% of the required tests at no additional cost. The Contractor shall furnish certified copies of all test reports to the Engineer within 3 days of completion of the specified tests.

6 1.11.2 The Contractor shall, within 7 days after the date of the Letter of Acceptance, submit to the Engineer for his consent a detailed description of the arrangements for conducting the quality control programme during execution of the Works, including details of his testing laboratory, equipment, staff and general procedures. If following submission, or at any time during the progress of Works, it appears to the Engineer that the Contractor's quality control programme is not adequate to ensure the quality of the Works, the Contractor shall produce a revised programme which will be adequate to ensure satisfactory quality control.

**7 1.12 Protection of Utilities**

8 1.12.1 The Contractor is required to carefully examine the location of the Works and their alignments and to make special enquiries with all authorities concerning all utility lines such as water, sewers, gas pipe, telephone (underground and/or overhead) lines, electric cable (underground and/or overhead) lines, etc.; and to determine and verify to his own satisfaction the character, sizes, position and

lengths of such utilities from authentic records. The Contractor shall be wholly responsible for the protection and/or facilitating relocation of such utilities as may be required, and shall not make any claim for extra work or extra time that may be required to protect or facilitate relocating such utilities. If any major shifting or realignment of water, sewers, gas pipes, electric and telephone lines is necessary due to their interference with the proposed Works, the same may be done by the Employer. The cost of such relocation will be borne by the Employer. In case the alignment of the pipeline crosses high tension electrical transmission lines belonging to the Karnataka Power Transmission Corporation Ltd. (KPTCL) or other authorities, the Contractor shall take all precautions necessary to see that the work is carried out with care and safety, without disturbing such transmission lines. The Contractor will be responsible to carry out all construction activities in such reaches in consultation with the owners of such facilities. However, satisfactory completion of the entire work will be the responsibility of the Contractor.

**9 1.13 Construction Methodology**

10 1.13.1 Tenderer shall submit the detailed construction methodology along the clear program of works while submitting the tender. The methodology shall include the safety measures to be adopted in the execution of work. Tenderer shall express in detail the methodology for addressing the Social & Environment factors during the execution of work.

11 **1.14 Deleted**

**12 1.16 Inspection and testing**

13 1.16.1 Inspection of Material to be procured

14 Inspection and certification of all materials used on the works such as DWC pipes, PVC pipes , Cement, Size Stones, Sand, aggregate, etc for conformity with specifications of BIS. If insisted, inspection of materials at the manufacture place shall be arranged by the contractor at his cost including the travelling and accommodation of the inspecting officer.

1.16.2 **Inspection and certification of the various components of works.**

Construction of DWC pipeline, PVC pipeline and construction of machineholes chambers including back filling of trench in layers with compaction as specified to ensure that all components of works are carried out as per specification and to required standards.

Inspection & Certification of Flow Test on Completed pipe line in reaches and as a whole network as specified shall be carried out. The hydraulic testing of the pipelines is to be certified by the third party and the in charge BWSSB Engineer.

**1.17 Technical Specifications**

15 1.17.1 Engineer shall have the right to modify/alter the Particular Specifications and/or Standard Specifications at any time which promise to confer equal or better quality than the standard specified in the tender document. Such modification or alteration shall be acceptable to the Contractor subject to no additional financial burden to either the Contractor or the Employer.

# Specification

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# Specifications

## 1.1. Scope Of Work.

The scope of work under this contract shall be as detailed above and as specified in Bill of Quantities in Section-7,

## 1.2. contractual requirements

1.2.1. Contractor's Inspection of Sites:

The Contractor is deemed to have visited the sites and familiarized himself of the conditions and restrictions under which the work will be executed. The omission of any details shall not relieve the Contractor of his prima facie obligation and responsibility under the Contract to carry out and successfully complete the rehabilitation works. The Employer will entertain no monetary or other claims, made by the Contractor on the grounds of 'want of knowledge'.

**THE CONTRACTOR IS ADVISED THAT IT IS HIS SOLE RESPONSIBILITY TO ASCERTAIN FOR HIMSELF THE EXTENT OF WORK THAT IS REQUIRED TO BE DONE IN SITE AND TO GENERALLY OBTAIN HIS OWN INFORMATION ON ALL MATTERS AFFECTING DIRECTLY OR INDIRECTLY THE EXECUTION OF THE WHOLE WORKS INVOLVED IN THE CONTRACT TO THE COMPLETE SATISFACTION OF THE ENGINEER. THE ENGINEER WILL ENTERTAIN NO CLAIM OF EXTRAS IN CONSEQUENCE OF ANY ALLEGED IGNORANCE IN ANY ASPECT. IT MUST BE CLEARLY AND DEFINITELY UNDERSTOOD THAT THE CONTRACTOR SHALL BE HELD SOLELY RESPONSIBLE FOR MAKING ALL NECESSARY ARRANGEMENTS AND COORDINATING WITH RELEVANT AUTHORITIES, COMPETENT AGENCIES AND SPECIALISTS ETC., TO ENSURE SATISFACTORY COMPLETION OF THE CONTRACT.**

1.2.2. Tender Drawings and Contract Documents:

a). Necessary Tender Drawings are enclosed along with this tender document. These drawings are made for Bidder's guidance only. "Released for Construction" drawings will be issued to the contractor during the progress of work. "Released for Construction" drawings may be revised, and revised copies will be issued to the contractor. "Released for construction" drawings will be issued progressively during the execution of works, broadly confirming to the basic scheme indicated in the specification drawings.

b). No claim will be entertained on the score that the details shown on "Released for Construction" drawings are different from those shown

on the specification Drawings, unless the drawings indicate such items of work which are not a part of Bill of Quantities.

c). None of these drawings/documents shall be used by the Contractor for any purpose other than that of the Contract.

d). All data and information furnished in the drawings by the Employer or his representative is given in good faith but the Employer does not accept the responsibility for the completeness and accuracy thereof. The same shall be verified by the Contractor promptly pointing out errors or discrepancies thereof to the Engineer.

Documents and drawings which are furnished to the contractor for the execution of works shall be kept on the site of work in good order and the same shall at all reasonable times be available for inspection and use by the Engineer, his representative, or other inspecting officers.

1.2.3. Time of completion.

Time period for completion of all the works shall be **6 Months** (inclusive of monsoon period) from the date of issue of notice to commence.Within this period Contractor shall be required to complete the works, including testing, commissioning and completion.

1.2.4. Work plan.

The Contractor shall prepare the work plan for the execution of works, which includes procurement of pipes before starting of the works. The Contractor shall submit the planning's (Construction, Financial, Quality and Commissioning and handing over planning's) within 14 days after issue of letter of acceptance and take necessary approvals for the same. The planning's shall be in the form of a PERT/CPM and a bar chart together with description of his proposed method of working. The planning shall include all allowances to guard against delays caused due to inclement weather or its effects (such as floods or draughts), fire or industrial disputes, unless such events could not reasonably have been foreseen by an experienced Contractor.

1.2.5. Alignment Survey and the L-Sections.

**The contractor shall carry out the Survey work for laying of sewage pipeline** for proposed alignment and levels, at every 30 meters interval and other necessary locations, before execution of the work, including all data required for generating L section and GIS maps of sewer network. Contractor shall submit the survey drawings showing L-Sections, ground levels at every 30 meters interval and other necessary locations, detailed strip plans showing adjacent structures etc., in latest version of AutoCAD for approval of

the Engineer before execution of the work. The Bidder has to consider this aspect and make provision, while quoting the rates for Sewer pipe supply, laying and jointing item in the tender. If the alignment and flow directions of the sewers are to be changed according to the site conditions and the Engineer In-charge agrees to that, the contractor has to redo the alignment and level survey at every 30m and junction points, and submit all the details in latest version of Auto Cad in soft form to BWSSB, for re-design of that particular stretch and take up the work on receipt of approved designsfrom BWSSB.

**Also, The contractor shall carry out the Survey work for laying of branch / submain /main / trunk sewers** for proposed alignment and levels, at every 30 meters interval and other necessary locations, before execution of the work, including all data required for generating L section and GIS maps of sewer network. Contractor shall submit the survey drawings showing L-Sections, ground levels at every 30 meters interval and other necessary locations, detailed strip plans showing adjacent structures etc., in latest version of AutoCAD for approval of the Engineer before execution of the work. The contractor shall take prior approval for location and length of the survey work for this paid item. The payment will be made as per the quoted rates for conducting survey in bill of quantities. If the alignment and flow directions of the sewers are to be changed according to the site conditions and the Engineer In-charge agrees to that, the contractor has to redo the alignment and level survey at every 30m and junction points, and submit all the details in latest version of Auto Cad in soft form to BWSSB, for re-design of that particular stretch and take up the work on receipt of approved designsfrom BWSSB.

The alignments, L-section and location of manholes may be changed at site if required, and after approval of the Engineer.

The Survey work for all the sewer lines (for all diameters of sewers) alignment shall also include the following,

a) All the Survey works shall be carried out from G.T.S. Benchmarks, using Total Station instrument of standard make, and by qualified survey personnel. The survey shall consist of field data collection and related attribute information collection of all the aspects pertaining to GIS mapping of sewer network before and after laying of sewer pipes and allied structures, as required by BWSSB.

b) Field attribute collection for Mapping with respect to Existing sewerage network does not require any digging in the field. The existing maps / BWSSB field staff knowledge can be utilized by the

bidder to provide the data for mapping the said network and it will be paid as per the survey work item in Bill of quantities.

c) Network entity's attribute information like pipe dia, pipe type, ground material, depth of the pipe, manhole type, manhole size, manhole depth etc. shall be submitted.

d) The contractor shall communicate regularly, with the BWSSB regarding the GIS mapping survey data and for clarifications.

1.2.6. Applicable I.S. codes or other Standards:

IS: 3764 with latest revisions & amendments ~ Excavation work- code of safety.

IS: 12330 with latest revisions & amendments ~ Specification for Sulphate resisting Portland cement.

IS: 8112 – with latest revisions & amendments specification for 43 grade OPC cement.

IS: 651:1992 with latest revisions & amendments ~ Specification for Salt glazed stone ware pipes & fittings.

IS: 4127:1967 with latest revisions & amendments ~ Code of practice for Laying of Glazed Stoneware Pipes.

EN: 295 with latest revisions & amendments ~ Specification for GSW pipes with rubber gasket joints.

EN: 681 & ASTM C-425 with latest revisions & amendments ~ Specification for Rubber gaskets and jointing of GSW pipes.

IS 458-1988, IS4350-1967 with latest revisions & amendments ~ Specification for pre-cast Concrete Pipes.

IS: 783-1959 with latest revisions & amendments ~ Code of Practice for Laying of Concrete Pipes.

IS: 8329:2000 with latest revisions & amendments ~ Specification for Ductile iron Pipes.

IS: 12288 with latest revisions & amendments ~ Code of practice for use & laying of ductile iron pipes.

IS: 4984:1995 with latest revisions & amendments ~ Specification for HDPE Pipes.

IS: 4111 (Part 1 to 4) with latest revisions & amendments ~ Code of practice for ancillary structures in sewerage system.

IS: 10910 with latest revisions & amendments ~ Specification for polypropylene & its co-polymers coatings.

IS 12592 with latest revisions & amendments ~ Specification for manholes covers and frames.

IS: 3597 with latest revisions & amendments ~Method of tests for concrete pipes.

IS: 5382 with latest revisions & amendments ~ specification for rubber sealing rings for gas mains, water mains and sewers.

IS: 383-1970 with latest revisions & amendments ~ Aggregates of Concrete.

IS 456:2000 with latest revisions & amendments ~ Code of practice for Plain & reinforced concrete.

IS:516 with latest revisions & amendments ~ Methods of test for strength of concrete.

IS:2212-1962 with latest revisions & amendments ~ code of practice for Brickwork.

IS:1957 (Part-I) with latest revisions & amendments ~ Construction of Rubble Stone Masonry.

IS:1957 (Part-II) with latest revisions & amendments ~ Construction of Ashlar Stone Masonry.

IS:2250 with latest revisions & amendments ~ Code of practice for preparation and use of masonry mortars.

IS:73 with latest revisions & amendments ~ Specification for Paving Bitumen.

IS:215 with latest revisions & amendments ~ Specification for Road Tar.

IS:217 with latest revisions & amendments ~ Specification for Cutback Bitumen.

IS:460 (Part 1 to 3) with latest revisions & amendments ~ Specification for Test Sieves.

IS:2386 (Part 1 to 8) with latest revisions & amendments ~ Methods of test for aggregates for concrete.

IS:2720 with latest revisions & amendments ~ Method of Test for soils.

IS:6241 with latest revisions & amendments ~ Method of test for determinations of stripping value of road aggregates.

IRC:16 with latest revisions & amendments ~ specification for priming of Base course with Bituminous Primers.

IRC:17 with latest revisions & amendments ~ Tentative for single coat Bituminous surface Dressing.

IRC:19 with latest revisions & amendments ~ Standard specification and code of practice for water bound macadam.

IRC:29 with latest revisions & amendments ~ Specification for bituminous concrete for road pavement.

1.2.7. Equivalency of Standards and Codes.

**Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise stated in the Contract. Where such standards and codes are national, or relate to a particular country or Region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be acceptable subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 7 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.**

1.2.8. Samples and Tests.

**The Contractor shall be responsible to develop a quality control program and to provide all necessary materials, apparatus, instruments, equipment, facilities, and qualified staff for sampling, testing and quality control of all the materials used for the works under this Contract. The Contractor shall obtain the approval of the Engineer for the quality control programme developed by him and incorporate any modifications suggested by the Engineer at no extra cost. Without limiting the generality of the foregoing, the Contractor shall either –**

**(i) establish a testing laboratory at the site of works which is adequately equipped and staffed to carry out all sampling and testing in accordance with the requirement set out in the Specifications and /or these Special Specifications and provide all field equipment and apparatus as necessary to conduct all specified in-situ tests and/or any Tests on Completion, or**

**(ii) arrange for routine sampling, testing and reporting, as required, through a certified independent testing laboratory approved by the Engineer.**

**All costs of such sampling, testing and reporting of test results will be borne by the Contractor, and the Contractor shall include sufficient provisions in his tendered rates to allow for independent sampling and laboratory testing under the direction of the Engineer of the required tests at no additional cost. The Contractor shall furnish certified copies of all test reports to the Engineer within 5 days of completion of the specified tests ( The tests shall be conducted immediately prior/after delivery at site as directed by the Engineer In-charge / on due date of sample testing, as per relevant IS for In-situ items.)**

**The Contractor shall, within 7 days after the date of the Letter of Acceptance, submit to the Engineer for his consent a detailed description of the arrangements for conducting the quality control program during execution of the Works, including details of his testing Laboratory, equipment, staff and general procedures. If following submission or at any time during the progress of Works, it appears to the Engineer that the Contractor's quality control programme is not adequate to ensure the quality of the Works, the Contractor shall produce a revised program as desired by the Engineer, which will be adequate to ensure satisfactory quality control.**

## a. Tests during Construction

**For ensuring the requisite quality of construction, the Materials and Works shall be subject to the quality control tests as described in relevant IS as specified /applicable and as directed by the Engineer. The testing frequencies set forth are desirable minimum and the Engineer shall have full authority to get the additional tests carried out by the Contractor as frequently as he may deem necessary, to satisfy himself that the Materials and Works comply with the appropriate Specifications.**

**Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted Engineering practices as per the directions of the Engineer.**

## B. Third Party Inspections.

The Contractor shall, at his own or manufacturers cost, at manufacturers premises, provide the necessary gauges, supply and prepare all test pieces and supply all labour and apparatus for testing which may be necessary for carrying out the tests as required as per relevant latest Indian Standard for all materials specified.

The Employer appointed Third party inspection agency will inspect and certify the quality of specified materials as per relevant latest Indian Standard with all amendments. The inspection and certification charges will be paid directly by BWSSB to the Third Party Inspecting and certifying Agency. The Contractor shall be responsible to obtain permission and provide all facilities to carry out such testing as required.

A mutually agreed quality assurance plan with, minimum requirements as specified below will be developed which provides for inspection and certification by the Third party inspection agency at specified times during the manufacture, fabrication and installation at site of such items.

**List of Items, which will be subject to, third party inspection and stages of inspections are as tabulated below:**

| Sl. No. | ITEMS | STAGES OF INSPECTION |
|---|---|---|
| 1). | SW pipes and specials | 1. Visual and Dimensions Check<br>2. Review of Chemical and Physical test certificates as per relevant IS standards.<br>3. Hydraulic Test and<br>4. All other tests as per relevant standards as mentioned in this Technical specifications and approved QAP. |
| 2). | PVC pipes and Specials. | 1. General Quality, Visual and dimension check as per as per relevant IS with latest revision and amendments.<br>2. Hydraulic test as per relevant IS with latest revision and amendments.<br>3. Acid and Alkali resistance test as per as per relevant IS with latest revision and amendments.<br>4. All other tests as per relevant standards as mentioned in this Technical specifications and approved QAP. |

| Sl. No. | ITEMS | STAGES OF INSPECTION |
|---|---|---|
| 3). | SFRC manholes covers and frames | 1. Tests conforming to IS 12592 part I-1989 and part II-1991 with latest amendments, Load test etc. and<br>2. All other tests as per relevant standards as mentioned in this Technical specifications and approved QAP. |

1.2.9. Sign Board

**The Contractor shall provide sign boards at the sites of the Works of approved size and design as directed by the Engineer, which provides (i) the name of the Project and the financing agency (World Bank loan); (ii) the names and addresses of the Employer, Contractor and Consultants; (iii) short description of the Project, (iv) the Contract amount (v) the starting and completion dates.**

**Such sign boards shall be located at specified places in the project coverage area as directed by the Engineer. Contractor shall take care of signboard and replace it in case of loss, damage, theft etc., the sign boards may be in English or Kannada or in both as directed by the Engineer.**

1.2.10. Protection of Utilities

**The Contractor is required to examine carefully the locations of the works and their alignments. Contractor is to make enquiries and co-ordinate with all the departments /authorities concerning all utility lines such as water pipes, sewers, gas pipe, telephone (underground and /or overhead) lines, optic fibre cables, electric and telecommunication cables (underground and /or overhead) , any other utility lines etc; to determine and verify to his satisfaction the character, sizes, position and lengths of such utilities from authentic records.**

**The Contractor shall be wholly responsible for the protection of such utilities as may be required, and shall not make any claim for extra work or extra time that may be required to protect such utilities. Any damage, to the Utilities shall be restored/ repaired at Contractor's own cost. Shifting of any utilities if required will be taken up by BWSSB or any other agency separately after site inspection.**

**In case of water supply house Service connections, if the connections encountered in the corridor of execution of the Bill of Quantities item of work of this package is damaged even after**

**taking all precautions by the contractors for the safety of the structures, the cost of the item shall be paid to the contractors as per approved Bill of Quantities item rates in the contract.**

In case the alignment of the pipeline crosses the high tension electrical transmission lines belonging to the KPTCL / BESCOM or other authorities/ departments, the Contractor shall take all precautions necessary to see that the work is carried out with care and safety, without disturbing such transmission lines. The Contractor will be responsible to carry out all construction activities in such reaches in consultation with the owners of such facilities. However, satisfactory completion of the entire work will be the responsibility of the Contractor.

1.2.11. Performance Requirements:

The performance requirements have been spelt out in various parts of the Contract specification. The Contractor shall ensure that, he fully understands and complies with all the requirements specified in the Contract. However, in the event of any conflicting performance requirements spelt out in the documents, the Contractor shall promptly bring such matters in writing to the attention of the Engineer for Engineers decision. The Engineer's decision will be conveyed to the Contractor in writing and which is final. The Contractor shall fully comply with Engineer's decision on the matter.

The Contractor is deemed to have read and understood all performance requirements before bidding and he shall have no claim whatsoever with respect to the Engineer's final decision on the matter.

1.2.12. Contractor's Obligations:

The Clauses in this section are meant to provide general guidelines and Compliance requirements to the Contractor. It does not however relieve the Contractor from taking every other step and precautions as deemed necessary to complete the works successfully within the specified Contract period and bid amount. Also, compliance to the approved Environmental management plan and monitoring the same is part of the contract.

**12.12.1. Environmental Management Plan and Monitoring.**

The Contractor shall be responsible for the mitigation measures to be taken for complying to the Environmental management plan and monitor as described below,

12.12.2. Environmental Management Plan - Construction Phase

Following measures are to taken by the Contractor for mitigating or minimizing the environmental impacts that are likely to occur during the construction phase of the project. The contractor under supervision and direction of Engineer in charge shall implement these mitigation measures. The cost for these measures and monitoring shall be included in the contract and no extra charges will be paid to the contractor separately.

**a).Minimum Environmental Management Measures.**

| Sl. No. | Potential Negative Impacts | Mitigation Measures | Time frame |
|---|---|---|---|
| 1. | Construction of labour camps | 1. Contractor shall follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp.<br>2. The location, layout and basic facility provision of each labour camp will be submitted to Engineer prior to their construction.<br>3. The construction will commence only upon the written approval of the Engineer.<br>4. The contractor shall maintain necessary living accommodation and ancillary facilities in functional and hygienic manner and as approved by the Engineer.<br>5. Contractor shall provide transportation facilities to the labour from the camp to the working site.<br>6. All temporary accommodation must be constructed and maintained in such a fashion that uncontaminated water is available for drinking, cooking and washing. The sewage system for the camp must be planned and implemented. Shall provide solid waste collection and disposal arrangements. Adequate health care is to be provided for the work force. The layout of the construction camp and details of the facilities provided should be prepared and shall be approved by the engineer. The construction camp shall not be located within 500m from the nearest water stream, residential areas and/or any sensitive land uses like schools, hospitals, etc. | Pre-construction and construction phase |
| 2. | Planning of temporary | i) Temporary diversion will be provided with the approval of the engineer. Detailed | Pre-construction |

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| | Traffic arrangements | traffic control plans will be prepared and submitted to the engineers for approval, at least two weeks prior to commencement of works.<br><br>ii) The traffic control plans shall contain details of temporary diversion, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, SIGNAGES, safety measures for transport of hazardous materials and arrangement of flagmen.<br><br>iii) Any accidents and/or risk of inconveniences caused to the community shall be borne by the contractor. | & construction phase |
| 3. | Storage of materials | The contractor shall identify the site for temporary use of land for construction sites /storage of construction materials including pipes, etc. These sites shall not cause any inconveniences to local population / traffic movement and shall not be located within 500 m from schools/hospitals. These locations shall be approved by the engineer and shall be operated only after the approval. | Pre-construction &construction phase |
| 4. | Protection of top soil | In case of opening of any virgin ground, the top soil to be protected in a separate and well designated area in trapezoidal shape not exceeding 3 m in length, 2 m width and 1.5m height. The top soil shall be restored after completion of works on appropriate locations like covering of pipelines, plantation areas of STP sites, any public and open lands and agricultural lands. | During construction |
| 5. | Storage of excavated earth | The contractor shall secure the excavated material for backfill purposes. The excavated material storage shall be maintained in such a way that the material will not block the drainages, hinder the traffic. The storage arrangements shall be approved by the engineer. After backfilling, the left out soil or debris at the storage location or by the side | |

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| | | of trenches shall be cleared. | |
| 6. | Disposal of construction debris and excavated materials. | Contractor will identify the sites for excess earth and debris disposal, prior to start of the earthworks; taking into account the following:<br><br>(a) The dumping shall not impact natural drainage courses<br><br>(b) no endangered / rare flora is impacted by such dumping<br><br>(c) Settlement area located at least 500 m away from the site.<br><br>(d) Located at least 1000m from the designated forest land.<br><br>(e) Avoid disposal on productive land.<br><br>(f) In case of community lands, should be located with the consensus of the local community , in consultation with the engineer | Pre-construction and Construction |
| 7. | Disposal of silt / sludge | A suitable site should be identified for safe disposal of silt / sludge generated from old sewers (preferably approved sludge disposal sites of STPs), excavations at the pumping / lifting station sites, which should be away from the water bodies, residential & sensitive areas, agricultural areas and etc., and got approved by the Engineer. | During construction and operation |
| 8. | Laying of sewer system | Adequate precautions should be taken while laying the sewer lines to avoid the possibility of cross connection with water supply lines. | During construction |
| 9. | Flooding in the low lying areas | Low lying areas in the project site can get flooded during monsoon period; to prevent the situation proper drainage arrangements has to be planned. All such areas shall be | Prior to initiation of construction |

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| | | identified prior to initiation of construction works and the appropriate drainage measures shall be established prior to initiation of construction works | |
| 10. | Temporary flooding due to excavation. | Proper drainage arrangements to be made, to avoid the overflowing of existing drains due to excavation during the laying of sewer mains. | During construction |
| 11. | Temporary water supply interruptions | i) Establish coordination with the concerned department to avoid or minimize the interruption of regular supply of drinking water to the residents.<br>ii) Proper alternative arrangements to be planned when interruption of drinking water supply to the near by residents.<br>iii) Prior intimation (at least 5 working days) shall be given in case of planned disruption of water supply. In the event of accidental disruptions, the supply lines shall be restored within 24 hours, and alternative water supply arrangement should be made. | Pre-construction and Construction |
| 12. | Using of modern machineries | Using of modern machineries such as JCBs, backhoes etc, shall be used to minimize the construction period, it will reduce the construction period impacts to the near by residents. | During construction |
| 13 | Prevention of | Prevention of accidents involving human beings, animals or vehicles falling or | During |

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| | accidents | accidents due to open trenches/manholes during construction period. This needs to be ensured with proper barricading, signage boards and lighting etc. | construction |
| 14 | Barricading site | The construction site should be barricaded at all time with adequate marking, flags, reflectors etc. for safety of general traffic movement and pedestrians. | During construction |
| 15 | Dust Pollution near settlements | i) All earth work will be protected in manner acceptable to the engineer to minimize generation of dust. Area under construction shall be water sprinkled.<br>ii) Construction material shall be covered or stored in such a manner so as to avoid being affected by wind direction.<br>iii) Unpaved haul roads near / passing through residential and commercial areas to be watered thrice a day. The costs thereof will be borne by the contractor<br>iv) Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage. | During construction |
| 16 | Protection of residential / sensitive receptors. | i) All the properties along the construction site shall be provided with clear access.<br>ii) Noisy construction operations in residential and sensitive areas should be carried out only between 7.30 am and 6.00 pm.<br>iii) Preventive maintenance of construction equipment and vehicles to meet emission standards and to keep them with low noise, including PUC certification to check air pollution. | During construction |

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| | | iv) Low noise generators shall be used.<br>v) The sensitive areas like Schools, hospitals to be provided with safety measures, and clear access to such places, prior to the start of work in order to minimize the dust and noise impacts due to vehicle movement during construction and their effectiveness to be checked during operation phase . | |
| 17 | Vehicular noise pollution at residential / sensitive receptors. | i) Idling of temporary trucks or other equipment should not be permitted during periods of loading / unloading or when they are not in active use. The practice must be ensured especially near residential / commercial / sensitive areas.<br>ii) Stationary construction equipment will be kept at least 500m away from sensitive receptors.<br>iii) All possible and practical measures to control noise emissions during drilling shall be employed. The Engineer may direct to take adequate controls measures depending on site conditions. | During construction |
| 18 | Noise from vehicles, plants and equipments | i) Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.<br>ii) Maintenance of vehicles, equipment and machinery shall be regular and up to the satisfaction of the Engineer to keep noise levels at the minimum. | During construction |
| 19. | Pollution from Fuel and Lubricants | i) The contractor shall ensure that all construction vehicle parking location, fuel/lubricants storage sites, vehicle, machinery and equipment maintenance and refueling sites shall be located away from rivers and irrigation canal/ponds. | construction and operation |

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| | | ii) Contractor shall ensure that all vehicle/machinery and equipment's operation, maintenance and refueling will be carried out in such a fashion that spillage of fuels and lubricants does not contaminate the ground.<br><br>iii) Contractor shall arrange for collection, storing and disposal of oily wastes to the pre-identified disposal sites (list to be submitted to Engineer) and approved by the Engineer. All spills and collected petroleum products will be disposed off in accordance with MoEF and state PCB guidelines.<br><br>iv) Engineer will certify that all arrangements comply with the guidelines of PCB/ MoEF or any other relevant laws. | |
| 20. | Pollution from Construction Wastes | The Contractor shall take all precautionary measures to prevent the wastewater generated during construction (e.g. during the testing of pipeline) from entering into streams, water bodies or the irrigation system. Engineer shall facilitate disposal of such water in to the nearest STP at the cost of the contractor.<br><br>All waste arising from the project is to be disposed off in the manner that is acceptable by the Engineer.<br><br>The engineer shall certify that all liquid wastes disposed off from the sites meet the acceptable discharge standard. | During Construction and post-construction |
| 21. | Safety Aspects | i) Proper barricading shall be provided as mentioned in the technical specifications of the contract and bill of quantities<br><br>ii) Adequate precautions shall be taken to prevent the accidents from the machineries. All machines used shall confirm to the relevant Indian standards Code and shall be regularly inspected by the Engineer.<br><br>iii) Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil as per the technical | During construction |

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| | | specifications of the contract.<br><br>iv) Personal Protective Equipment such as footwear and protective goggles to all workers employed on mixing of materials like cement, concrete etc.shall be provided.<br><br>v) Welder's protective eye-shields shall be provided to workers who are engaged in welding works.<br><br>vi) Earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation.<br><br>vii) The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, mask etc to workers and staffs.<br><br>The contractor will comply with all the precautions as required for ensuring the safety of the workmen as per the International Labor Organization (ILO) Convention No. 62 as far as those are applicable to this contract.<br><br>The contractor will make sure that during the construction work all relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Services) Act, 1996 are adhered to.<br><br>The contractor shall not employ any person below the age of 14 years for any work and no woman will be employed on the work of painting with products containing lead in any form. | |
| 22. | First Aid | The contractor shall arrange for:<br><br>i) A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone<br><br>ii) Availability of suitable transport at all times to take injured or sick person(s) | During construction |

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| | | to the nearest hospital | |
| 23. | Chance Found Archeological Property | All fossils, coins, articles of value of antiquity, structures and other remains or things of geological or archaeological interest discovered on the site shall be the property of the Government and shall be dealt with as per provisions of the relevant legislation.<br><br>The contractor will take reasonable precautions to prevent his workmen or any other persons from removing and damaging any such article or thing. He will, immediately upon discovery thereof and before removal acquaint the Engineer of such discovery and carry out the SC's instructions for dealing with the same, waiting which all work shall be stopped.<br><br>The Engineer will seek direction from the Archaeological Survey of India (ASI) before instructing the Contractor in above such cases to recommence the work in the site. | Construction |
| 24. | Tree Protection, | • Giving due protection to the trees that fall in the shoulders /corridor of impact shall be the prime focus during Construction/post construction<br>• Any requirement of cutting of trees shall be notified to the engineer in advance of commencement of work | Corridor of Impact |
| 25. | Monitoring of environment parameters | The contractor shall undertake seasonal monitoring of air, water, and noise and soil quality through an approved monitoring agency. The parameter to be monitored, frequency and duration of monitoring plan shall be prepared | Project area |
| 26. | Clearing of construction of camps and restoration | Contractor to prepare site restoration plans for approval by the engineer. The plan is to be implemented by the contractor prior to demobilization.<br><br>On completion of the works, all temporary structures will be cleared away, all rubbish cleared, excreta or other disposal pits or trenches filled in and effectively sealed off and the site left clean and tidy, at the | Corridor of Impact |

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| | | contractor’s expenses, to the entire satisfaction of the engineer. The substantial completion certification will be issued only after clearing of all construction camp sites. | |

B). PENALTY ON ACCOUNT OF NON-COMPLIANCE:

**IF THE CONTRACTOR IN THE OPINION OF THE ENGINEER IN-CHARGE DOES NOT COMPLY TO THE ENVIRONMENTAL MANAGEMENT PLAN AND MONITORING, THE ENGINEER IN-CHARGE RESERVES THE RIGHT TO STOP THE WORK AND ANY DELAY ON ACCOUNT OF THIS WILL BE ON THE PART OF THE CONTRACTOR AND PENALTY AS PER LIQUIDATED DAMAGES CLAUSE IN CONDITIONS OF CONTRACT AND CONTRACT DATA SHALL BE IMPOSED UPON APPROVAL BY THE CONCERNED EXECUTIVE ENGINEER, BWSSB.**

1.2.13. Confined Space Safety Procedure:

The contractor shall implement a well-prepared Space Entry Safety Procedure to work in Confined areas / Elevated areas. Such procedures shall incorporate all aspects of staff work activities, internationally adopted best practices, site staff and workmen training, hazard awareness, first aid procedures, particularly applicable to workmen in Elevated / Confined space, provision and use of appropriate safety equipment’s, personal hygiene, safety / emergency procedures, method of easy evacuation of workers etc. The Contractor has to develop and implement his own safety procedures. He should also provide necessary insurance to the workers involved in the execution of work.

1.2.14. Special Traffic Precautions.

Contractors Attention is specially drawn to the requirements by the traffic police and road authorities and specification regarding traffic control, access and reinstatement of road surface. It is necessary to obtain permission from traffic Inspector of Police prior to taking up any stretch of road for excavation and sewer laying. It is necessary to carry out the work in such a manner as to cause minimum interference with the public use of roads, footpaths and other thoroug

1.2.15. Working in Restricted areas.

In addition to the clause stated in other section of the special specification the Contractor shall determine prior to constructing the lengths of sewers where access to properties commercial, domestic and institutional will be restricted.

The identification of these areas shall be agreed in consultation with the Engineer, Police and Urban local body. In this case it may be necessary to operate one-way traffic system or to close roads. The Contractor shall be responsible for liaising with the police and other local representatives to obtain permission to close roads or restrict traffic movement. No additional time will be allowed for these pre-construction activities. Where roads are closed alternative routes are to be determined in conjunction with the authorities. Sign Boards are to be placed at both junctions of the route indicating “ROAD CLOSED & WORK UNDER PROGRESS”. The expense for the same shall be borne by the contractor. The Contractor shall discuss these arrangements with the occupants of houses affected to ensure that their disruption is kept to a minimum. The Contractor is to offer assistance to residents who are infirm or need special arrangements for access during construction.

In narrow roads and streets it may not be possible to operate excavation machinery in such cases hand excavation is to be done. The method of operation, length of sewer to be excavated, method of barricading, property access, dewatering, shoring, pipe laying, backfilling and road reinstatement shall be stated in a ‘Method Statement’ to be submitted at least 4 weeks before work is scheduled to commence in a particular location. The written agreement of the Engineer shall be obtained to the method statement. If any additional safeguards are required by the Engineer these shall be incorporated in the method statement at no extra cost and the method statement is to be resubmitted.

The Contractor will ensure that the noise created by his activities is suppressed. Adequate silencers fitted to construction machinery, particularly compressors and drills. Dust is to be kept to a minimum by using water sprinklers. Utility service connections shall be maintained to every property throughout the construction phase and thereafter. If any defect/ damage is caused it shall be repaired immediately and at the Contractors expense. The disruption to the normal activities of residents and other members of the public is to be kept to an absolute minimum. Providing adequate noise control and other nuisances are kept to a minimum, extended working hours may be permitted with the agreement of the Engineer and local residents. No additional payment shall be made for any of these arrangements unless other wise specified. Adequate lighting shall be provided by the Contractor at his cost if night working is adopted.

1.2.16. Interfaces with other packages.

If this contract Package will have interface with other contracts, the contractor shall only undertake the end connections of sewers at the

interface points, after the sewer has passed the hydraulic test on completion of end connections. The contractor shall lay the bedding and backfill for sewers in normal manner.

1.2.17. Order Of Precedence Within Bid Documents

In the event there is any conflict or discrepancy within the Bidding documents, the order of Precedence will be determined as follows;

1. Addendum
2. Contract data
3. Instruction to Bidders
4. Invitation to Bid
5. General conditions contract including special conditions contract
6. Technical specifications
7. Bill of quantities.
8. Drawings

1.2.18. Technical and Supervisory Staff.

Contractors shall employ the following minimum number of Technical and supervisory staff excluding other staff as required for the project, during the contract period and it does not relieve the contractor of his responsibility for employing, such, more number of employees for satisfactory and timely completion of the project work.

Following are the minimum number of Technical and supervisory staff,

| **Sl No.** | **Description.** | **Number of personnel** |
|---|---|---|
| 1. | Project manager | 1 |

| | | |
|---|---|---|
| 2. | Site Engineers | 2 |
| 3. | Site Supervisors/Inspectors. | 4 |

The Technical and Supervisory staff Employed by the Contractor shall have the minimum qualification and work Experience as mentioned below,

a). Project Manager - B.E. in Civil Engineering, with minimum 10 years experience.

b). Site Engineer - B.E. in Civil Engineering with minimum 2 years experience or Diploma in Civil Engineering with minimum 5 years experience.

c) Site Supervisors/Inspectors - Diploma in Civil Engineering with minimum 1 year experience or S.S.L.C. with minimum 5 years experience in construction industry.

### 1.2.19 MEASUREMNTS & PAYMENTS.

#### 1.2.19.1. MEASUREMENTS

**a. Quantities**

The quantities set out in the Bill of Quantities are the estimated quantities for the Works, and they are not be taken as the actual and correct quantities of the Works to be executed by the Contractor in fulfillment of his obligations under the Contract.

**b. Works to be Measured**

The Engineer shall, except as otherwise stated, ascertain and determine by measurement the value of the works in accordance with the contract and the contractor shall be paid that value in accordance with applicable clauses of this contract. The Engineer shall, when he requires any part of the works to be measured, give reasonable notice to the Contractor’s authorized agent, who shall:

a) forthwith attend or send a qualified representative to assist the Engineer or his representative in making such measurement, and

b) supply all particulars required by the Engineer or his representative.

Should the Contractor not attend, or neglect or omit to send such representative, then the measurement made by the Engineer or his representative or approved by him shall be taken to be the correct measurement for such part of the works. For the purpose of measuring such Permanent Works as are to be measured by records and drawings, the Engineer shall prepare such records and drawings as the work proceeds as he deems necessary or appropriate and the Contractor, as and when called upon to do so in writing, shall within 14 days, attend to examine and agree such records and drawings with the Engineer and shall sign the same when so agreed. If after examination of such records and drawings, the contractor does not agree the same or does not sign the same as agreed, they shall nevertheless be taken to be correct, unless the Contractor, within 14 days of such examination, lodges with the Engineer notice of the respects in which such records and drawings are claimed by him to be incorrect. On receipt of such notice, the Engineer shall review the records and drawings and either confirm or vary them.

**c. Method of Measurement**

The Works shall be measured net, notwithstanding any general or local custom, except where otherwise provided for in the Contract.

**1.2.19.2. PAYMENTS.**

No part payments will be made for all items of works under this contract, except for pipeline works, which will be paid as mentioned in contract data.

## 2.0 EARTHWORK EXCAVATIONS.

### 2.1. General

**The Earthwork Excavation for laying of sewers shall be carried out as per applicable IS specifications, specification in the Bill of quantities and applicable clauses in this specifications.**

**The Contractor shall make all excavations required for laying and jointing of the pipeline and construction of pertinent structures as required by the project. Except where otherwise required by the project or instructed by the Engineer, all excavation shall be in open cut, to the specified widths and depths with shoring, strutting and bracing. The Contractor is advised to satisfy himself and quote rates accordingly with regard to the likely conditions that may be met with during the execution of the works, with regard to the underground obstructions or conditions, necessary dewatering requirements including well point system or other means of dewatering the trenches before, during and after excavation, laying**

**of bedding material, laying and jointing sewers, hydraulic testing and till backfilling, construction of manholes, pipe supports etc., in sub terrain under ground water, rain water, sewage and waste water etc.**

**Earth work excavation for pipeline trenches and manhole chambers including depositing on bank including, danger lighting and using sight rails and boning rods, including shoring, strutting, bailing out water at every 100 metres wherever necessary as directed in the various strata with lead upto 30 meters and all lifts etc., complete. A minimum of three numbers of sight rails are to be maintained at all times during pipe laying between manholes, including barricading as per directions of Engineer In-charge of work. (The Excavation cost should include the cost of shoring, strutting to facilitate for laying, jointing & testing of sewers, manholes.)**

2.2. Classification of Excavation

**i). All Soils includes the following,**

a). Soft clay, soft murrum, gravel shale etc. including. Stiff heavy clay, hard shale or compact murrum requiring drifting tool or pick axe or both and shovel closely applied.

b). Gravel, soft laterite, kankar and cobble stone having maximum diameter in anyone direction between 75 mm and 300 mm.

c). Soling of road paths etc., and hard core.

d). Macadam surfaces such as water-bound and bitumen/tar bound.

e). Lime concrete, stone masonry in lime/cement mortar below ground level.

f). Soft Conglomerate, where the stones may be detached from the matrix with pick axe.

g). Generally any material which requires the close application of pick axe or scarifiers to loosen and not offering resistance to digging, greater than that offered by the hardest of any soil mentioned above.

**ii). D.I.R. soft rock and medium hard rock includes,**

a). Ordinary rock comprising of lime stone, sand stone, hard laterite fissured rock, conglomerate or other soft or disintegrated rock which may be quarried or split with crow bars.

b). Un-reinforced cement concrete which may be broken up with crow bars or pick axe and stone masonry in cement mortar below ground level.

c). Boulders which do not require blasting having maximum diameter in any direction of more than 300 mm; found lying loose on the surface or embedded in river bed, soil, talus, slope wash, and terrace material of dissimilar origin.

d). Hard laterite does not require blasting. It is to be classified under ordinary rock which does not require blasting.

**iii). Hard Rock includes,**

a). Any rock or cement concrete or RCC, excavation of which require the use of mechanical equipment or chiselling.

## *2.2.1. All soils.*

The Earth work excavation in all soils, including the ones mixed with boulders of up to 30 cms size, includes excavation both by **manual andmachine excavation** based on location of excavation and space constraints. The quoted rates are applicable for both manual and machine excavation, the location and extent of manual and machine excavation should be as described below,

**a). Manual excavation.**

The manual excavation for laying the sewers in pipeline trenches shall be carried out as decided and directed by the Engineer In-charge, along the alignment of such narrow roads and main roads where it is not possible for machine excavation and, at excavations in deeper depths of more than 3m, providing all safety measures to workmen at contractor’s risk, also, manual excavation is to be adopted at the possible locations of under ground utilities to safeguard against damage.

**b). Machine excavation.**

The machine excavation for laying the sewers in pipeline trenches shall be carried out along the alignment of wide roads and in depths where there are no under ground utilities without causing any damage to public property, and inconvenience to public.

## *Disintegrated Rock, Soft Rock and Soft Shale*

**This category includes excavation in disintegrated rock, soft rock, soft shale and in medium rock comprising of lime stone, hard shale, schist, fissured rock, and all types of laterite with varying**

**densities and composition requiring chiseling which can be cut by shovel and but without resorting to blasting.**

## *Hard Rock*

**This category includes excavation in hard rock requiring hand and/or mechanical chiselling.**

**In case of difference in opinion between the classifications of rocks, the decision of the Engineer shall be final and binding on the Contractor.**

2.3. Shoring and Bracing

**As per Specifications and directions of the Engineer, the Contractor shall supply, fix and maintain necessary sheathing, shoring and bracing etc., in steel or wood, as may be required to support the sides of the excavation, to protect workmen in the trench and to prevent any trench movement which might any way injure or delay the work, change the required width of the trench, make unsafe condition for adjacent pavements, utilities, buildings or other structures above or below ground.**

**Sheathing, shoring and bracing shall be withdrawn and removed as the backfilling is being done, except when the Engineer may agree that such sheathing, shoring and bracing be left in place, at the Contractor's request. In any case, the Contractor shall cut off any such sheathing at least 600 mm below the surface and shall remove the cut off material from the trench.**

**All sheathing, shoring and bracing which is left in place under the foregoing provisions shall be removed in a manner so as to, not endanger the completed work or other structures, utilities or property, whether public or private.**

2.4. Excavation in Rock

**Excavation in rock shall be carried out without resorting to any kind of blasting, to a depth, 150 mm more than the bottom level of pipe and to a width equal to the diameter of the pipe plus specified working space on either side as given in drawing / as mentioned above. Unless otherwise directed by the Engineer, rock excavation shall be progressed at least by 20 m in advance of the pipe length proposed to be laid.**

2.5. Limits of excavation.

**The trench for laying of sewers and construction of manholes shall be excavated in accordance with the relevant applicable Indian standard, as per the approved drawings, or as directed by the Engineer. The width at bottom of trenches for sewers, unless otherwise specified in the approved construction drawings, or directed and approved by Engineer, for different diameters of pipes laid at different depths shall be as given below,**

**a). For all diameters, up to an average depth of 1.20 m, width of trench in mm is equal to diameter of pipe plus 300 mm.**

**b). For all diameters for depths above 1.20 m, width of trench in mm is equal to diameter of pipe plus 400 mm.**

**c). Not with standing (a). and (b). the total width of trench should not be less than 0.75 meters for depths exceeding 0.90 meters.**

**The width at top of trenches for sewers shall depend on depth of sewer, location and alignment of sewer, as per the approved construction drawings and directions of Engineer. Unless other wise specified in the drawings or directed by Engineer, for providing of sheet piling as per specifications in Bill of quantities, the top widths for excavations up to 2 meters depth shall be equal to bottom width (i.e. vertical side cuts.) and for depths beyond two meters depth, for all types of soils/rock, steps shall be provided of 0.30 m width on either side of the trench at every lift of 2 meters and as per the directions of Engineer. The quoted rates for excavations in accordance with the above specifications shall include all shoring and strutting for all depths.**

**The depth of excavations shall limit to the specified gradients/reduced levels as per the approved construction drawings at ends, considering the necessary beddings/encasement/surround.**

**The Contractor shall not excavate beyond the dimensions specified as above. Should the excavation occur beyond the dimensions specified therein, because of the negligence of the Contractor, the Contractor shall fill the excess space with granular material or concrete as directed by the Engineer. Nothing extra shall be paid to the Contractor on account of this. The contractor shall quote the rates for excavation items, limiting the trench widths as above for whatsoever depths encountered, including necessary arrangements as required. Any extra claim and increase in quantity other than the widths specified above, shall not be entertained or paid.**

2.6. Trial pits

**Trial pits shall be excavated by the Contractor, as directed to do so, along the lines of the trenches as shown on the drawings in advance of the excavations for the purpose of satisfying himself as to the location of under ground utilities, obstructions or soil strata's and conditions. Trial pits shall be excavated preferably by manual excavation. The contractor has to take the permission of the concerned Executive Engineer, BWSSB, before taking up the work.**

**It involves, Earth work excavation for trial pits in all kinds of strata and for all depths, recording necessary details of under ground utilities and kind of strata, including depositing on bank excavated earth, including barricading, posting safety sign boards, shoring, strutting, bailing out water, wherever necessary as directed with all lead and lifts etc., complete. Any damage to the existing utilities unless otherwise specified shall be repaired at Contractors own cost. The Precautionary measures shall be taken by the Contractor while making trial pits and shall inform the Engineer before commencing such works. The contractor will be paid as per the item in BOQ on account of this work.**

2.7. Dewatering

**Extra charges will be paid at quoted rates, for excavation in all classifications in watery situation or foul conditions towards dewatering including overnight recuperation for specified depth ranges with all lead and lifts etc., complete, including cost of installation and running of dewatering system such as well point system / any other system wherever required.**

**Dewatering shall be done in accordance with specifications. The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation in case of inundation etc., of trenches. The sewer lines shall be laid above normal ground water table level and as directed by the Engineer. Dewatering shall be either continuous or intermittent using Diesel pump or any othermethod approved by the Engineer. The method of dewatering shall depend on site condition and should be furnished by the Contractor and approved by the Engineer. The method of dewatering shall be either well point system or sump pumping. The effectiveness of each method will depend upon the nature of the soil, the proportions of the trench and degree of lowering required. Pumping test may be necessary to determine which method is Suitable.**

**If sump pumping is not practicable other control methods shall be considered and should be approved by the Engineer. The trenches should be kept dry till the completion of work, which includes excavation, pipeline laying, jointing, testing and commissioning and backfilling. Precaution should be taken against the floatation of the pipes.**

**The Contractor shall conduct ground studies if found necessary and the cost for such studies has to be borne by the Contractor himself. The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water met due to all causes from the excavation for laying sewer lines, construction of manholes, wet wells and all types of constructions. In case of failure to make such provisions or any other provisions, which may result in unsuitable sub-grade conditions, the Contractor shall replace and repair the sub-grade as directed to the satisfaction of the Engineer, at his own cost and responsibility. Should the Contractor select to use a gravel sub-grade with or without un jointed pipes with the gravel layers to facilitate flow of water to pumps or other points of disposal, such gravel sub grade with or without conveying pipes shall not be measured or paid as an extra item.**

- Sump pumping

**This method may be used in highly and moderately permeable soils such as gravels, sand and gravel mixtures. This method is simple and cheap to install and used with watertight trench sheeting to limit the volume of flow. To prevent the boiling in the bottom of the trench the following precaution should be taken**

- **Drive sheeting deeper to lengthen drainage path**
- **Use open pipe surrounded in gravel as a sump.**
- **Move the sump to one side of the trench**

**To prevent removal of fines from soil causing loss of strength in the soil and undermining of the trench bottom and side support**

- **Surround suction inlet with protected graded filter**
- **Increase flow rate through the soil by using open pipe surrounded with gravel.**

**The delivery side of the pump should be monitored by taking samples of water and checking the proportion of fines being removed. If fines are being continuously withdrawn or there are signs of trench instability, sump pumping should be stopped and alternative methods to the considered.**

- Well pointing

**In this method, well points are installed at regular intervals on one or both sides of the trench and linked parallel to a header main connected to a pump. Well points are usually installed at 0.6 to 2.0m centre to centre by jetting them in ground with dense layers or cobbles & boulders it may be necessary to pre bore the layers. The efficiency of the well points is increased by sanding in the well point and riser using a column of sharp sand. This Method has an advantage of drawing water away from the trench and in suitable conditions is effective in lowering the water by 4 to 6m. It will also reduce the hydrostatic heads on the trench support system. It is of greatest use, in sand, the heavy flows in permeable ground, such as gravels, the well points should not to be so close together that the method becomes impractical. In clays the rate of seepage is too small for the system to be properly effective. Silts can be stabilized in certain conditions by using special procedures.**

**The well pointing shall be either single sided well point or double sided well point. For higher depths double sided well point with multi stage shall be considered. Should the Contractor select to use a gravel sub-grade to facilitate flow of water to pumps or other points of disposal, such gravel sub-grade shall not be measured or paid for as an extra item. Contractor should assess the availability of extra earth required for refilling in case of shortage in any particular reach well before quoting rates. Even in case the Contractor resorts to mechanical excavation, the Contractor should take care of proper refilling, consolidation and disposal of surplus earth. Disposal of ground water is to be away from the area of influence of the pipe laying area Suitable temporary pipelines are to be laid to existing watercourses.**

## 2.8. Slips and slides

**The Contractor is responsible for proper protection of excavations made by him from any slips and slides. All slides and caving shall be handled, removed or corrected by the Contractor without any extra compensation at whatever time and under whatever circumstances they may occur. The excavations shall be**

**made good and brought to necessary depth, width and levels without any extra cost. Special care should be taken to protect the safety of the workmen, staff and public or whoever at the site.**

2.9. Stacking of excavated material

**Pursuant to specification in Bill of Quantities or directions of Engineer in-charge of execution, the excavated material shall be stacked at suitable locations so as not to cause any inconvenience to the public or traffic, with all safety measures in accordance with IS 3764 with latest revisions and amendments. The excavated material shall be placed away from the sides of the trench. The excavated materials shall be stacked at a suitable distance, keeping in view the safety aspect of working personnel due to sliding and slippage based on nature of soil and condition. The contractor shall be solely responsible for the untoward incident caused due to his negligence of stacking the excavated material. Under circumstances where in, sewers have to be laid in narrow pathways, the excavated material shall be transported or placed with all lifts & lead as detailed in bill of quantities to the nearby suitable place or as decided by the Engineer and brought back after laying and jointing for refilling of the trenches as per specifications under clause 2.11.**

2.10 Barricading.

**The contractor shall Provide, erect and remove casurina pole three tier barricading using poles of 7.50 to 10 cms. Dia. And 1.50m height above ground fixed vertically at intervals of 2.0 to 2.5 mtrs. C/C and Horizontally at 0.50 mtrs, above ground level, including fixing poles in the ground for a minimum depth of 0.30 mtr. and tied with coir rope firmly including cost and conveyance of all materials, labour, lead and lift charges complete. The work will be paid as per the item in the BOQ.**

2.11 Carting and Re-Carting of Excavated earth.

**The carting of excavated earth, of all types and at all depths, from trenches is to be carried out, for laying of sewers and construction of manholes in narrow roads and other roads where there is a space constraint, and at locations directed by the Engineer In-charge.**

where the trenches are to be backfilled with the same excavated earth, the excavated earth shall be Carted to a lead distance detailed in bill of quantities &stacking of earth at identified suitable site and re-carting back the stacked earth to the same site by vehicle, including loading , unloading

charges for to & fro, with all lifts, labour, HOM of machinery etc. complete. Lead distance indicated is one side distance only. Bidder shall quote the rate for to & fro lead distance., Also, Disposing off the excess excavated Earth of manhole chambers & pipeline trenches of all types to a lead distance detailed in bill of quantities by vehicle, including neatly stacking, loading , unloading, with all lifts, labour, HOM of machinery etc. complete

The responsibility of locating the site for stacking or disposal of excavated earth shall be the responsibility of the contractor, in coordination with the BWSSB. Stacking/Disposal of earth shall not cause inconvenience to public or other agencies and should not cause environmental problems. The location and extent of the above specified work shall be taken up by the contractor, only after the approval and proper directions by the concerned Executive Engineer, BWSSB. The work will be paid as per the item in BOQ.

## 2.12. Safety measures

**Pursuant to Specifications in bill of quantities, relevant Indian standards or directions of the Engineer, the Contractor shall provide adequate safety measures. They shall include:**

1. Barricading all sides of the open trenches.

2. Red danger lights as can be easily visible from dusk to dawn at an interval of 20 m and at all the road crossings.

3. Traffic signals and display boards giving direction for diversion of traffic at the appropriate places as may be directed by the Engineer.

4. Adequately safe wooden plank / board or steel plate over the trenches at every 15 meters interval or less depending upon access requirement to commercial, institutional and domestic properties to facilitate crossing by the public residing on either side of the trench.

5. Round the clock watch and ward maintaining all safety regulations at the site of work and protecting the site from unauthorized intrusions.

6. The work due to the above facilities/arrangements by the contractor will be paid for the items in bill of quantities and the cost for the remaining shall be deemed to be included in the relative items of work.

## 2.13. Progress of Excavation

**The Contractor shall adjust excavation of trenches in such lengths that the pipes can be laid in such exposed portion of the**

**trench within 3 days / less than 3 days as per criticality of site condition and directions of the Engineer.**

**Unless otherwise directed by the Engineer, the following limitations for lengths of open trenches shall rule for a pipeline in one continuous reach.**

**Not more than 50 m in built up area and 150 m elsewhere shall be opened in advance of pipe laying.**

**Not more than 50 m of pipeline left uncovered after pipe laying in built up areas and not more than 150 m elsewhere.**

2.14. Excavation for Manholes and Other Appurtenant Structures.

**Excavation for Manholes and other appurtenant structures shall be done in accordance with the applicable clauses from 2.1 to 2.14 of this Section. The Contractor shall excavate as required for all the structures with foundations to firm, undisturbed earth up to the level of the under side of the structure.**

**If the excavation is in rock, the Contractor shall excavate all rock at least to the minimum limits shown in approved drawings.**

**The standard details for trenches and to the grade of the bottom of Manholes and other structures are as per applicable clauses in this section and construction drawings issued for the execution of work. Where the bottom of the structure is in rock, it should be ensured that no rock shall project above the lower surface of the concrete in such a manner so as to reduce the required thickness of concrete placed simultaneously as an integral part of the foundation and to the outside of structure foundation where structure is to be built.**

**The Contractor shall excavate the trench / pit to provide necessary working space on all sides and for accommodating any sheathing, shoring or bracing etc.**

2.15. Works Included in Excavation

**The following works as per specifications are also included in excavation and the term 'Excavation' shall construe to mean all such items of work. The quoted rates should include the same:**

Provision of side space or additional space in the trench / pit for working and /or accommodating sheathing, shoring, bracing, etc.

Supply, installation and removal after the work, all-sheathing, shoring and bracing required, protecting the excavation where required or where such work is recommended by the Engineer.

The bidder shall verify the site conditions and wherever such dewatering is required it is considered that the rates quoted for dewatering item of work are inclusive of dewatering of surface and sub-surface water.

Protection of excavations.

Providing adequate safety measures.

Additional work in connection with overhead wires and poles.

Excavations for socket and collar hollows.

Supplying and fixing of sight rails and boning rods in the trench to facilitate measurement of work etc. complete

Temporary approaches to roads, properties etc., affected by excavation at no extra cost.

2.16. Sheet piling.

Trenching at locations along the alignments of Trunk sewers or other locations where vertical cutting of trenches is necessary as directed by Engineer, Sheet piling shall be provided as per the item in bill of quantities and the specifications in this section.

The contractor shall Provide and install steel sheeting or sheet piling for both sides of the trench for various depths detailed in bill of quantities, with mild steel sheets not less than 6.5 mm thick, stronger knife edge, recessed spreader sockets, single or double wall shields to be designed by the contractor to withstand all types of soils, maximum depths upto 12 m, as approved by the Engineer including all materials, equipment and labour charges for installing and removing the sheet piling at various reaches of sewer line construction, including loading, unloading, transporting to the suitable location etc complete as directed by the Engineer-in-charge.

The location and extent of sheet piling shall be got approved by the contractor from the concerned Executive Engineer, BWSSB prior to starting this work. Measurement for the sheet piling work shall be taken and paid for, on one face of wall shield only. Sheet piling will be measured for payment by the number of square meters of sheet piling completed and accepted, as computed from the horizontal and vertical payment lines shown on the plans or as ordered. The limits used for payment will be the actual horizontal limit of temporary sheet piling installed and accepted, and the vertical limit will be as measured from the bottom of the exposed face of the sheeting to the top of the trench. No measurement will be made for end extensions.

2.17. Measurements.

**The Earthwork excavation shall be measured net. Unit of measurement shall be in cubic meters, and the measurements are limited to deci-meters (Two decimal places). Dimensions for the purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundation of the walls, columns, footings, tanks, rafts or other foundations/structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the specifications and construction drawings. Excavations in side slopes will not be paid for. Contractor may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation. No payment will be made for working space except where clearly indicated in the drawing or is essential in the opinion of the Engineer. Where concreting is proposed against the excavated sides, no such over excavation will be permitted. In such cases over excavation shall be made good by the contractor with concrete of the class as in the foundations at his own cost.**

**Trench excavation for sewers shall be measured using the dimensions detailed in the standard section shown on the construction drawings. Excavation beyond the widths or depths required will not be paid for, any additional concrete or bedding material required as a result of over excavation will be at the contractor's expense.**

**Backfilling for trenches shall be measured and paid separately. Volume of rock excavated shall be calculated on the basis of length, breadth and depth of excavation indicated on the construction drawings and the limits of excavation clause of this section. No payment will be made for excavation/over break beyond payment line specified. Where such measurement is not possible as in the case of strata intermixed with soil, excavated rock shall be properly stacked as directed by the Engineer and the volume of rock stacked will be calculated on the basis of stack measurements after making appropriate allowance for voids. The allowance to be made for voids shall be decided by the Engineer.**

**Excavation in paved roads, pavements and concrete shall be billed separately and will be measured in cubic meter The quantities of paved roads and pavements will be calculated from the length of the trench excavated measured between the centers of two adjacent manholes multiplied by the standard width indicated on the drawings or the applicable clause in this section for the particular diameter of pipe and the actual measured depth of the road surfacing material. The quantities of concrete broken out during excavation will be calculated from the actual measured quantities.**

3.**0**Clas*s* SN8 Double Wall Corrugated HDPE

*3.1. Manufacture of pipe.*

Providing and installation of Class SN8 Double Wall Corrugated HDPE pipe outer wall corrugated and inner wall smooth piping system in accordance with IS 16098 part 2 and conveying to work site and lowering into trenches, laying true to line and level and perfect linking at joints with the help of two "O" rings and a coupler of suitable size, including loading and unloading at both destination and cutting of pipes where ever necessary including jointing with all labour, all lead and lift including encasing the pipe around to a depth of not less than 15 cm with screened soft soil available from the excavated soil. The testing commissioning including necessary hydraulic test to the required pressure as per ISS shall be done the contractor shall have to make his own arrangement for procuring water for testing etc. complete.

*3.2. Testing of pipes at manufacturing unit.*

**latest relevant IS standard, and tested in accordance with the methods described in relevant IS including the following,**

Hydraulic test

Absorption test

Test for Acid Resistance

Test for Alkali Resistance

Crushing Strength test.

***3.3. Marking***

**Marking shall be done conforming to relevant IS codes approved by the Engineer. The following information shall be clearly marked on each pipe,**

**a). Internal diameter of pipe.**

**b). Class of pipe.**

**c). Date of manufacture and**

**d). Name of manufacture or his registered trade-mark or both.**

*3.4. Carting & Handling*

**All Pipes and fittings/specials shall be transported from the factory to the work sites at places along the alignment of pipeline as approved by Engineer in lengths not more than the length of the transporting vehicle. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from**

**the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes and / or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. As far as possible, pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for replacement. Any pipe, which shows damage in the opinion of Engineer, shall be discarded and replaced by new one without extra cost. Dragging of pipes and fitting/specials along road or pipeline alignment shall be prohibited.**

*3.5. Trenching.*

**Trenching includes all excavation which shall be carried out either by hand or by machine and shall be carried out in accordance with all requirements of Earth work excavations clause 2.0 to 2.17. wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all round the socket in order to make the joint, and the grip shall be maintained clear, until the joint has been approved by Engineer**

*3.6. Bedding:*

Before laying of GSW sewer pipes, necessary bedding (granular, concrete cradle, concrete arch etc.) shall be provided in accordance with approved construction drawings and as per detailed specifications

*3.7. Laying of pipe*

**Laying of DWC pipes shall conform to the relevant code**

**.**

*3.8. Jointing of pipes*

The jointing of GSW pipes shall be carried out as per relevant IS codes

*3.9. Measurement of pipes.*

**The length of the sewer pipes shall be measured between the inner surfaces of consecutive manholes at the invert level of the pipes along the central line of pipeline to the nearest centimeter.**

*3.10. Testing at work site.*

After laying and jointing of pipes is completed, the pipe line shall be tested at work site as per all the requirements in clause 9.0 to 9.5 of this section and as approved by the Engineer.

*3.11. Backfilling.*

Backfilling shall be in accordance with requirements specified in clause of backfilling.

**Personal Safety Requirements:-**

The personnel at site shall strictly adhere to Standard guidelines during the chemical coating activity, at all times. The approved coating manufacturer shall supply complete standard requirement schedules for the personnel to follow, prior to start of any coating application. The general requirements are:-

Observe the owners standard policy at all times and obey all written and verbal instructions from site managers and representatives.

Wear all PPE at all times including Hard Hat, Safety glasses, Boots, Gloves and masks as required.

When preparing and applying coatings and chemical materials all PPE must be worn including Gloves, safety glasses and protective paper masks.

When using high pressure plural component spray equipment, all personnel working in the application area must wear double filter breathers with OSHA or of atleast equivalent make.

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*Backfilling.*

Backfilling shall be in accordance with requirements specified in clause 6.3 *Testing at work site.*

After laying and jointing of pipes is completed, the pipe line shall be tested at work site as per all the requirements in clause 9.1 to 9.1.4 of technical specifications and as approved by the Engineer.

*5.11. Backfilling.*

Backfilling shall be in accordance with requirements specified in clause 6.3 to 6.3.4. of backfilling.

*7.3.1. Wire cut Brick Manholes.*

7.3.1.1. Construction.

The work shall be executed in accordance with the approved construction drawings and specifications involving,

a). Providing and constructing of 1:3:6 Cement Concrete foundation using approved quality aggregates of 40mm and downsize with an offset of 150mm all round the chamber.

b). Providing and constructing wire cut brick masonry in C.M 1:4 proportion using modular wire cut bricks of class designation 75 of approved quality and confirming to IS : 1077 with a tapering top portion as per approved construction drawings and providing cement mortar plaster in CM 1:3 proportion, 12mm thick inside and outside except for the conical surface outside, where the thickness of plaster shall be 20mm thick.Samples of bricks shall be tested as per IS : 3495 by the Contractor. Bricks rejected by the Engineer shall be removed from the site within 24 hours.Construction of Brick works shall be in accordance with IS 2212:1962 and latest revisions.

c). Providing and constructing benching with Cement Concrete 1:2:4 to the dimensions as on drawings with 1:6 slope in the concrete towards the central drain, plastered with CM 1:3 proportion, 20mm thick and finished with smooth coat of neat cement and fixing of inlet and outlet sewers in the walls with the internal periphery protected with an arch of 1:2:4 Cement Concrete with graded metal of 10mm to 20mm size.

d). Supplying and fixing of, 3 mm thick plastic (as per IS: 10910) encapsulated over 12mm dia. Fe-415 steel (as per IS: 1786) bar footsteps staggered at 300mm apart and providing and fixing of heavy duty circular steel fibre reinforced concrete (SFRC) manhole frame and covers of 560 mm diameter conforming to IS 12592 and the payment for providing of SFRC heavy duty manhole frame and covers shall be paid separately as per quoted rate for the item in bill of quantities.

e). The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

f). The manhole construction work includes curing, pouring tar over MH frame and cover, cost of tar, engraving manhole number and flow direction on the inner surfaces etc., with all lead and lifts, finishing etc complete. The cement used for the

construction of masonry works and internal & external plastering works of manholes shall be of sulphate resisting cement only confirming to IS:12330.

**7.3.1.2. Testing.**

**All Brick Manholes shall be tested as per relevant provisions in CPHEEO Manual & relevant IS with latest revisions & amendments and specifications in clause 9.0 of Testing and commissioning.**

**7.3.1.3. Measurement & payment.**

**The depth of manhole shall be measured from the top of cover to the invert level of the deepest outgoing sewer from the manhole.The quoted rate for the Manholes for various depths as per the specifications and drawings shall include the cost of sulphate resisting cement, bedding concrete, benching concrete, wire cut brick masonry, plastering, foot steps, fixing SFRC manhole frame with cover, dewatering to keep the manhole dry until final testing etc complete.**

**The Rates for any fractional variation (increase or decrease) in the depth of the manhole on decimetre basis, shall be paid as per actuals, by adding the difference in rates between the immediately preceding and succeeding depths of such fractional depth of manhole on linear basis.**

***For Example: To pay 1.22M depth manhole:***

***Rate for 1M depth Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. X.***

***Rate for 2 M depths Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. Y.***

***Therefore rate for 1.22M depth Manhole***

***= Rs. X + (Y-X)/1.00 x 0.22.***

*Note: For the depths of manholes less than the lowest depths of Bill of Quantities item, the preceding manhole depth shall be taken as zero with zero value to arrive at the rate*

*7.3.2. RCC Manholes.*

**7.3.2.1. Construction.**

The construction of RCC manholes shall be by Cast In-situ of Circular in shape or approved type Pre-Cast RCC, constructed using form vibrators of standard type, using SRC Cement confirming to IS: 12330. The type of manhole to be constructed

shall be as approved by BWSSB, Contractor shall take prior approval for the Design and Process of manufacture of the Pre-cast RCC manholes, the type of vibration for compaction of concrete for pre-cast manholes shall be invariably of form or table vibrator type.

**The work of Cast In-situ RCC manholes includes,**

a). Providing and constructing of 1:3:6 Cement Concrete foundation using approved quality aggregates of 40mm and downsize with an offset as given in the drawings.

b). Providing and laying granite jelly cement concrete 1:1.5:3 for beds of manholes etc., using 20mm and down size jelly including laying, tamping, etc. for a depth, as per drawings, with water proof compound for top plaster in CM 1:3 curing and smooth finishing for exposed faces with necessary centering and form work etc., complete as per specification, drawing and as directed by the Engineer.

c). Providing and laying cement concrete of 1:1.5:3 proportion for vertical walls using 20mm and down size jelly including laying, tamping, mixing of required quantity of water proof compound for every one bag of cement for plastering in CM 1:3 curing and smooth finishing for exposed faces with necessary centering and form work etc., complete as per specification, drawing and as directed by the Engineer.

d). Providing and constructing benching with Cement Concrete 1:1.5:3 to the dimensions as on drawings with 1:6 slope in the concrete towards the central drain, plastered with CM 1:3 proportion, 20mm thick and finished with smooth coat of neat cement and fixing of inlet and outlet sewers in the walls with the internal periphery protected with an arch of 1:1.5:3 Cement Concrete with graded metal of 10mm to 20mm size.

e). Providing and laying cement concrete of grade 1:1.50:3 proportion with 12mm to 20mm I.S.I gauge of approved gradation hard broken granite/aggregate including cost and conveyance of all materials with wood or steel shuttering form work including machine mixing , centering form work, scaffolding, tamping , vibrating , curing and smooth finish with CM 1:3, 12mm thick for inside surface for RCC Covering Flat Slab with all lead and lifts, etc. complete as per drawing, specification and as directed by the Engineer.

f). Providing, Supplying and fabricating of TMT (Fe-500) reinforcement steel of all sizes, including straightening, cutting, bending, hooking, lapping and/or welding wherever required, placing in position, tieing with binding wire of approved quality and gauge including the cost of binding wire and anchoring to adjoining members wherever necessary including all laps and wastages etc., with all lead and lifts, complete as per design, specification and directed by Engineer.

g). Supplying and fixing of, 3 mm thick plastic (as per IS: 10910) encapsulated over 12mm dia. Fe-415 steel (as per IS: 1786) bar footsteps staggered at 300mm apart and providing and fixing of heavy duty circular steel fibre reinforced concrete

(SFRC) manhole frame and covers of 560 mm diameter conforming to IS 12592 and the payment for providing of SFRC heavy duty manhole frame and covers shall be paid separately as per quoted rate for the item in bill of quantities.

h). The RCC Manhole cost includes all materials, steel, curing, pouring tar over MH frame and cover, cost of tar, engraving manhole number and flow direction on the inner surfaces etc., with all lead and lifts, finishing etc complete. The cement used for the construction of RCC manhole and internal & external plastering works of manholes shall be of sulphate resisting cement only, confirming to IS:12330.

**The work of construction of Pre-cast RCC manhole includes,**

a). Providing & laying mechanically mixed cement concrete of M-15 grade with stone aggregate (with 20 mm nominal size graded stone aggregate) in benching, Neat cement punning over PCC benching, as given in the drawings.

b). Construction of approved type vibrated Pre-Cast RCC Manhole Chambers constructed using Sulphate resistant Cement & form vibrator of standard type for Circular Manhole Chambers of various internal dia (as indicated in BOQ) at bottom and 0.50 dia at top made up of pre-cast monolithic base, modular riser and top cone in M- 30 grade concrete placed & aligned to provide vertical sides, with O ring rubber gasket at each joint, water tight & adjustment rings over top cone, complete and all connections shall have, a water tight seal between the pipe and the manhole complete as per standard design & drawing.

c). Making connection of drain or sewer line with existing manhole including breaking in to and making good the walls, floors etc. with CC 1:1:5:3. Finishing with CM 1:3 with a floating coat of neat cement and making necessary channels for drain etc. as per specification, drawing and as directed by the Engineer.

d). Providing, Supplying and fabricating of TMT (Fe-500) reinforcement steel of all sizes, including straightening, cutting, bending, hooking, lapping and/or welding wherever required, placing in position, tieing with binding wire of approved quality and gauge including the cost of binding wire and anchoring to adjoining members wherever necessary including all laps and wastages etc., with all lead and lifts, complete as per design, specification and directed by Engineer.

e). Providing MS Foot rests and fixing in manhole with CC Block of 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate of 20 mm nominal size) of size 20x20x10 cm with 20mm square bar foot rest, and providing and fixing of heavy duty circular steel fibre reinforced concrete (SFRC) manhole frame and covers of 560 mm diameter conforming to IS 12592 and the payment for providing of SFRC heavy duty manhole frame and covers shall be paid separately as per quoted rate for the item in bill of quantities.

f). The RCC Manhole cost includes providing danger lighting & use of sight rails & boning roads shoring & strutting wherever required, including sand bedding, watering, curing, cost of all materials, labour, supply & fabrication of steel, pouring tar over MH frame and cover, cost of tar, engraving manhole number and flow

direction on the inner surfaces etc., with all lead and lifts, finishing etc complete. The cement used for the construction of RCC manhole and internal & external plastering works of manholes shall be of sulphate resisting cement only, confirming to IS:12330.

**7.3.2.2. Testing.**

**All RCC Manholes shall be tested as in specifications in clause 9.1.3. of Testing of manholes.**

**7.3.2.3. Measurement & payment.**

**The depth of manhole both for Cast In-Situ / Pre-Cast RCC manholes shall be measured from the top of cover to the invert level of the deepest outgoing sewer from the manhole. The quoted rate for the Manholes for various depths as per the specifications and drawings shall include the cost of sulphate resisting cement, bedding concrete, benching concrete, RCC floor & roof slab, shaft walls, plastering, foot steps, fixing SFRC manhole frame with cover, dewatering to keep the manhole dry until final testing etc complete.**

**The Rates for any fractional variation (increase or decrease) in the depth of the manhole on decimetre basis shall be paid as per actuals, by adding the difference in rates between the immediately preceding and succeeding depths of such fractional depth of manhole on linear basis.**

***For Example: To pay 1.22M depth manhole:***

***Rate for 1M depth Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. X.***

***Rate for 2 M depths Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. Y.***

***Therefore rate for 1.22M depth Manhole***

***= Rs. X + (Y-X)/1.00 x 0.22.***

*Note: For the depths of manholes less than the lowest depths of Bill of Quantities item, the preceding manhole depth shall be taken as zero with zero value to arrive at the rate.*

7.4. Drop Manholes.

**In a manhole, wherever the difference between the invert level of downstream sewer and the invert level of the upstream sewer is greater than 60 cm, a drop manhole shall be provided at that position. The locations and construction of the drop manholes shall be provided as on drawings.**

**HDPE Grade PE-100 pipes confirming to PN 6 as per IS:4984 with latest revisions and amendments suitably supported with MS fasteners at 300 mm c/c. for diameters pipe line as per Bill of Quantities, construction drawings and as directed by Engineer, specials conforming to IS: 1729 shall be used for providing the drop in the manhole & a suitable expander/reducer T-Joint at the top with incoming sewer and 45 degree bend at the bottom with HDPE specials to the direction of flow in the receiving sewer, encasing the pipe with cement concrete of 1:2:4 proportion including necessary centering and form work, vibrating, curing, including cost and conveyance of all materials, labour with all lead and lifts, etc., complete as per specification and as in construction drawing. The benching concrete in the manhole should surround the joint of the terminating bend and a neat channel shall be made in the benching concrete to direct the flow to the receiving sewer. A continuation of the incoming sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with half blank flange as on drawing. The drop manhole arrangements shall be tested along with sewer lines.**

7.5. Vent shafts.

CI Vent shafts shall be erected at places as on construction drawings or as directed by Engineer and as per Bill of Quantities. The work includes providing and fixing 150mm diameter, Cast Iron pipe for ventilating shaft of 5 meters high with specials and cowl and with suitable grips in C.C. 1:2:4 pillar using 10mm to 20mm graded hard granite/trap/basalt or any other approved metal with 15 cms thick C.C. around up to 1.22 mtrs above the GL and with a foundation base of 90x90x90 cms plastered with 12 mm thick CM 1:3 to all exposed faces and linking the shaft to the manhole by means of 15 cm dia GSW pipes and specials, jointing with tar dipped hemp 1:1 1/2 CM caulking, curing with all lead and lifts etc., complete for all materials earth work excavation and refilling in all strata, and disposal of surplus earth as directed with all lead and lifts etc. complete.(Sulphate resistant cement shall be used).

g to IS 12330-1988 with latest amendments.

**8.1.3. Location and Protection of Existing Public and Private Utilities.**

Prior to excavation, the Contractor shall contact all **concerned authorities such as KPTCL, BMP, Local municipalities, police, telecommunications, forest department, KIADB, BDA** etc and householders in roads where work is to take place and inform them of the nature of the work and its likely duration. Information should be obtained from utilities companies about the location of their utilities, preferably in the form of record drawings, and the Contractor should carry out

utilities tracing using electronic equipment to verify the positions of utilities. Trial excavations should also be carried by hand to further confirm locations of utilities. The Engineer will only permit trench excavation to proceed when he is satisfied that adequate efforts have been made to establish the alignments and depths of existing utilities

**Any damage to water supply utility connections which may occur during execution of House service connections, even after taking all necessary precautions by the contractor shall be paid as per rates quoted for the specified item indicated in Bill of Quantities.**

**The damaged water supply house connections shall be restored with MDPE pipes including Encasing the MDPE Pipe with 40mm dia., MDPE Pipe at sewer crossings etc, The cost includes encasing the MDPE Pipe with 40mm dia. MDPE Pipe with all works complete as directed by the Engineer In-charge for items under heading "Miscellaneous works" in bill of quantities. The decision in this matter made by the Engineer in charge of work / concerned Executive engineer of BWSSB shall be final and binding upon the contractor. For damaged soak pits and not to cause inconvenience to the public, the soak pits damaged during excavation shall be restored as per items in bill of quantities. However for any damage to other service utilities, the contractor shall make good the same at his own cost. No extra payment towards this will be made.**

**8.2. Existing Sewerage System Survey.**

It is anticipated that in the existing sewerage system, leaving the portion executed by BWSSB, the system is not maintained properly and the system may not be functioning properly at certain locations. Hence the level survey of the existing sewerage system executed by the agencies other than BWSSB has been included in this tender. It is the intended to retain portion of existing system which is properly functioning and suitable to be included into proposed network.

The contract covers, Conducting Level Survey of Existing UGD system by Collecting ground levels, invert level of sewers, Size and type(MOC) of Sewers and at every manhole, including depth of manhole and measuring length in between manholes and safely closing the manhole cover, preparation and submission of Drawings in AutoCAD with all particulars in complete manner as per specification and as directed by the Engineer in charge.(The Manholes and sewers will be de-silted and cleared using sewer cleaning machine by BWSSB, Levels shall be carried by the contractor, from the nearest Bench mark given by BWSSB).

BWSSB will cross verify the adaptability of existing sewer network with the proposed network, and decision will be given to retain or reject the part or whole of the existing sewer network and the contractor shall carry out the same in accordance with the items in the Bill of quantities and as directed by Engineer. For laying of new sewers in place of damaged and unserviceable existing sewers, the earthwork excavation shall be measured including existing damaged sewers under

all soils classification, the new sewer lines in place of damaged one's, dismantling of existing damaged manholes and reconstruction of the same shall be done as per items in BOQ. The diversion of sewage for in service sewer lines and manholes, if required during this work will be done by the BWSSB.

The contractor shall collect all necessary specified details required for developing sewer network plan for providing the existing system network plan in Auto Cad. And also incorporate the same in the "AS BUILT DRAWINGS" of executed new works.

**Payment: -** payment to contractor on completion of this item of work complying to the specifications above will be paid as per quoted rate and unit of measurement is meters.

**9.0. TESTING AND COMMISSIONING.**

**9.1.Testing at site.**

**All sewers and appurtenances shall be tested before commissioning and trial run as per the specifications in this section. After laying and jointing of sewer pipes and before backfilling the trenches, the complete length of the sewer is to be checked for water tightness and the sole responsibility of arranging the necessary equipments and apparatus lies with the contractor at his own cost. Any damage during testing shall be contractor's responsibility and shall be rectified by him free of cost. Water for testing shall be arranged by the Contractor at his own cost.**

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**10.4. Utility Service structures:**

The contractor shall replace at his own cost towards damage of any utility service structures during the excavation and rehabilitate if necessary at his own cost.

**10.5.2. Materials**

a**). Pipe**

Pipe used in this method includes an external casing pipe (also called jacking pipe) and may include an interior carrier pipe.

**b). Allowable Forces**

Considerable ramming / jacking forces may be required to install pipe using this method.

i). Casing pipe shall be obtained from one manufacturer. Pipe shall be specifically designed and certified for Horizontal auger boring by the pipe manufacturer.

ii). The allowable jacking strength capacity of casing pipe shall be capable of withstanding the maximum jacking forces imposed by the operation. The specified

allowable jacking capacity of the casing pipe shall be 3 times greater than the maximum jacking forces imposed by jacking operations as identified by theoretical calculations.

iii) Steel casing pipe shall have minimum yield strength of 35,000 psi.

**Scope of Work**

The scope of work includes all labour, materials and equipments and to perform all the work necessary to design and construct pipe lines crossing under paved roads, railway crossing using Manual pipe jacking. Construction shall be by using appropriate equipment and contractor shall propose the location of all working shafts having due regard to existing services, minimizing disruption to traffic and pedestrian movement. Locations shall be approved by the engineer prior to the commencement of construction. The contractor shall obtain approval of his method statement from the Engineer before commencement of the work.

**Design**

The contractor shall be responsible for the design of the pipes used for the trenchless method including all joilnts for the design of thrust and reception pits including support and thrust wall for the design of the jacking system in general. His design will be reviewed by the Engineer but this will not relieve him of his responsibility for the adequqcy of the design.

**10.6.3 Submittals**

In addition to the applicable requirements of this specification, the following shall be submitted by the contractor and approved by the Engineer prior to commencement of any works;

1 Programme of work with resource and equipment allocations.

2 Additional soil investigations

3 Design calculations for the non disruptive method

a) Pipes including jacking and friction forces in the axial direction and earth, traffic and surcharge loading in the vertical direction and pipes resistance to these loads. Also allowable deflections at joints to limit damage to the joint from eccentric loading under thurst and sealing limits.

b) Thrust and reception pits to resist external soil and water pressures and stresses resulting from jacking machine. Drawing showing on plan and sections the method of supporting excavations and equipment layout shall be included. All calculations shall be certified / signed by a qualified Engineer.

4 Materials specifications and product data.

5 Method statement shall include

a) List of equipment and resources

b) Detailed step by step procedure describing how work will be carried out including clear definition of responsibilities and authority

c) Support of existing services and adjacent structures

d) Safety arrangement for compliance with safety requirements.

e) Arrangements for dealing with ground water taking due regard to controlling the loss of materials and preventing settlement around pits pit pipe interface and tunnel face

f) Dealing with different ground conditions

g) Locking pipe in position during insertion of next pipe

h) Sealing thrust and reception pits during exiting and entering of pipe

i) Control of overbreak

j) grout mix design and method of grouting

**10.6.6 Quality Assurance**

The pipe line installation by manual pipe jacking shall be executed by firms having a record of at least three years of successful trouble free execution of similar works

**Delivery Storage and Handling**

All materials shall be properly protected so that no damage or deterioration shall occur during a prolonged delay

**10.6.8 Site Investigation**

Soil conditions and ground conditions shall constitute the Contractors risk. After award of the contract the contractor shall be responsible for carrying out all geotechnical site investigation including ground water level monitoring which he considers necessary but as a minimum at the proposed access pit locations and central median. The contractor‘s site investigation programme shall be submitted to the engineer for review. The results of such investigation shall be submitted to the engineer and shall include recommendations for pipe laying, excavation support and soil stabilization if required.

**Health and Safety**

The contractor shall adopt safe working practices for pipe jacking in accordance with appropriate standards. Only authorized persons shall be allowed access to the site. The Contractor shall provide a safety officer suitably experienced in tunneling operations and with adequate authority to control and implement safe working practices.

The contractor shall make suitable arrangements for accommodating his personnel at the site including the following as a minimum:

Telephone service.

Approved gas detectors.

First aid kit.

One vehicle.

The excavated pits shall have a separate cage type ladder bay complete with ladder in addition to any other bay or bays required for the construction of the works.

The pits shall be fenced off on all sides with close steel panels at least 1.8m in height and equipped with safety warning lights. The panels (maximum space between 100mm) shall be joined by steel rods supported on concrete blocks.

Adequate lighting and ventilation shall be provided to the pits and electricity shall be supplied at no greater than 110/220 volts.

**Skilled Operators and Supervision**

All operators in the employment of the Contractor shall be skilled and experienced in their respective trades and in particular shall be fully skilled in shaft sinking and manual pipe jacking.

The pipe manufacturer has to guarantee that this pipe and its material are suitable for its intended use.

Standard pipes shall be a minimum in length subject to the installation method used. Where required, pipes shall incorporate lubricant injection holes spaced equally around the circumference. Concrete pipes with a liner shall only be permitted to have lubricant injection holes in the concrete. Lubrication holes shall be clear of joints and shall be plugged on completion of the work. The liner shall be made good and continuous. Pipes may incorporate lifting holes and fixing holes for securing temporary apparatus. All such holes shall be threaded to enable plugs to be screwed into the sockets to withstand any external water pressures.

Joints which shall be used in conjunction with a resilient packing, shall be capable of accepting repeated annular deflections of up to 10 without.

damage to pipe  or loss of structural strength.

The ingress or egress of water or lubricant under the maximum operational or test pressures.

The ingress of soil / groundwater on to the bearing surfaces.

The joint design for concrete pipes shall be such that the areas available for transmitting the maximum permitted thrust force will be sufficient to ensure that with an annular deflection of 10 and with resilient packing material in place the maximum pressure applied to the joint bearing surface will not exceed 23.5 N/mm2 for drives in excess of 100 metres and up to 150 metres in length.

Unless independently authenticated test results acceptable to the Engineer are available, two consecutive axial loading tests incorporating a 10 angular deflection with the application of double the maximum permissible thrust force (or, if greater, of the greatest thrust force that the proposed thrust equipment can apply) shall have been successfully conducted without any visible crushing, cracking or spalling of the pipe being evident, before any pipes will be accepted for use. The test shall be extended to record the loading at which any visible signs of failure become evident, and shall be carried out in an approved manner to simulate actual working conditions. Pipes which have been submitted to the proof load test will not be permitted in the Works.

Where the Contractor elects to construct certain sections within larger diameter pipes and grout the annular space, the external pipe may be of steel with full circumferential weld. The steel pipe and the grout shall be regarded as sacrificial and the inner pipe shall be designed as a stand alone pipe, capable of withstanding installation and grouting forces and soil, traffic and groundwater loads

_____

**b) CONSTRUCTION INSPECTION**

a). Verify traffic control is consistent with the permit requirements, and the permits are available on-site.

b). Verify job site layout is consistent with the approved plans, especially the alignment of the pipe and machine.

c). Verify continuous monitoring records indicate bearing and grade of the leading edge of the pipe is consistent with the approved plans, dewatering effort is satisfactory, soil volume removed is consistent with projection, and that workers understand the contingency plan.

d) Verify pipe characteristics are consistent with permit requirements.

e) Verify steel pipe is new with smooth interior and exterior surfaces, is used within the entire influence area of the roadbed, has clean and square ends, joints are watertight, defective pipe is not used, and damaged pipe is removed.

Verify each end of the pipe is sealed with a cap, restoration is completed, and attach Inspector’s Daily Report (IDR).

Permit No. _____

Inspector: _____

Date: _____

**10.7. Other Related works.**

**10.7.1. Settlement/Heaving Monitoring.**

The trench less method of pipe laying shall be performed in a manner that will minimize the movement of the ground in front of, above, and surrounding the ramming/jacking operation: and will minimize subsidence of the surface above and in the vicinity of the ramming. The ground shall be supported in a manner to prevent loss of ground and keep the perimeter and face of the boring stable at all times, including during shutdown periods.

Potential settlement shall be monitored at each edge of right of way, each shoulder point, each edge of pavement, the each edge of each lane (or centerline for two lane roads), and otherwise at 15m intervals along the pipe centerline.

A survey shall be performed one day prior to initiating this operation at each required monitoring location. A similar survey shall then be performed at each location, on a daily basis, until the permitted activity has received a final inspection. This survey establishes the pre-existing and post construction conditions, and the amount of settlement. All survey readings shall be recorded to the nearest one-hundredth (0.01) of a meter. Whenever possible, trench less pipe installations shall not be installed directly under a pavement crack. Digital photograph of a pavement condition shall also be taken prior and after the pipe installation.

All operations shall stop immediately whenever monitored points indicate a vertical change in elevation of 12mm or more, or any surface disruption is observed. The Contractor shall then immediately report the amount of settlement to the Engineer with all records.

**10.7.2. Ground Water Control.**

Dewatering shall be conducted wherever there is high ground water table level to prevent flooding and facilitate the operation. The water table elevation shall be maintained at least 600mm below the bottom of the casing at all times. When needed, dewatering may be initiated prior to any excavation and will be paid as per the item in bill of quantities.

Minor water seepage or pockets of saturated soil may be effectively controlled through bailing or pumping. This control shall be accomplished without removing any adjacent soil that could weaken or undermine any access pit, its supports, or other nearby structure.

Larger volume of ground water shall be controlled with one or more well points or with staged deep wells. Well points and staged deep well pumping system shall be installed and operated without damaged to property or structures, and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other contractors. Any pumping methods of de-watering and control of ground water and seepage shall have properly designated filters to ensure that the adjacent soil is not pumped along with the water. Well diameter, well spacing and the pump's pumping rate, shall provide adequate draw down of the water level. Wells shall be located to intercept ground water that otherwise would enter the access pit excavation and interfere with the work. Upon removal of a well, the hole shall be filled and grouted.

Existing storm sewer shall only be used to discharge water from the dewatering operation in accordance with a permit obtained from the appropriate storm sewer owner. Filters of sediment control devices shall be required to ensure that the existing system is not adversely affected by construction debris or sediment.

If grouting is used to prevent ground water from entering the area of the access from pit, the grouting shall be installed without damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other contractor.

Whenever a significant amount of unexpected groundwater enters an access pit, and a catastrophic pit failure is imminent, the pit shall be backfilled immediately, until the groundwater level is at least 600 mm below the bottom of the casing.

**10.7.3 Boring failure**

Should anything prevent complete of this operation, the reminders of the pipe shall be constructed by the methods approved by the Engineer. Abandonment of any component of the installation shall be allowed as approved by the Engineer. If obstru.ction is encountered which prevents completion of installation of pipes, pipe remain shall be taken out of service and immediately filled with flowable fill.

**10.7.4. Contamination.**

When an area of contaminated ground is encountered, all operations shall stop immediately, and shall not proceed until approved by the Engineers. Any slurry shall be tested for contamination and disposed off, in a manner, which meets local, State and/ of federal requirements.

**10.7.5. Bulk head.**

Casing ends shall be enclosed or bulk headed with a 1:.1.5.:3 proportion concrete, or approved alternate to seal the ends to prevent water leakage or earth infiltration. The concrete shall extend longitudinally into the pipe end opening to

create a minimum 300 mm thick bulk head barrier, or as required by permit. Engineers may allow rubber bulkheads in special situations.

**10.7.6. Work site Restoration.**

a). Access pits and excavation shall be backfilled with suitable material, and in a method approved by Engineer.

b). The disturbed grass surface area shall be top soiled, seeded, fertilized, mulched, and anchored according to the current owners specifications. If a final site restoration is not completed within 5 days after completion of the operation, the installation of temporary soil erosion and sedimentation control measures shall be provided.

c). upon completion of the work, the contractor shall remove and properly dispose off all access materials and equipments from the work site.

d). The permit, including the surety requirements, shall remain in effect for a minimum of one year after completing the work to monitor for settlements of the pavement and /or slope.

**10.8. Interface between contracts**

The contractor shall under take the end connections at the interface points only after the pipe line as passed the Hydraulic tests on completion. After completing the end connections the contractor shall lay the bed and surround and backfill the trench in the normal manner.

**10.9. Payments.**

The payment for the works under Trench less method of pipe laying by Pipe Ramming/Manual pipe Jacking method will be made after executing according to the above specifications as per the relevant items in BOQ. All costs for works executed under the above specifications that are apart from the items in bill of quantities, shall be included in the item for installation of Casing Pipe by ramming / Manual pipe jacking method, No extra claim in this regard is entertained.

## 11.0 Reinstatement of roads.

**The road restoration / reinstatement shall be carried out after completion and necessary testing of all the Works and only after approval of the Engineer.**

**Contractor shall make good of the road surface to the original grade, level and specifications as per Bill of Quantities. Trenches shall be backfilled in layers as per clause mentioned in this section, well watered and well compacted before road restoration to avoid settlement of restored strip. In case any settlement of the road restoration strip, the Contractor has to rectify the surface by redoing the restoration work at no extra cost to the owner as per Bill of Quantities. Road restoration shall be done as per the**

**requirements of the concerned local authorities, requirements specified in this section of Technical specifications and as directed by the Engineer. The replacement of road structures shall be carried out as soon as practicable and in conformity with IRC guidelines after backfilling has been completed. Suitable excavated road pavement which complies with the requirements of the Engineer may be used at the sub-base levels. Compaction shall be carried out with approved mechanical compacting equipments.**

**The edges of the trench shall be cut to form a straight line consistent with fixed width of trench. A vertical joint shall be formed between the new work and the existing road surface and shall be painted with hot bitumen or rich cement slurry as the case may be, as approved by the Engineer. The joint between the base course and wearing course shall be stepped 75 mm.**

**The finished levels of the completed reinstatement shall conform with the adjoining carriageway surface. Reinstatement of the wearing courses shall match as nearly as practicable the colour or other characteristics of the existing surface.**

## 11.1. WATER BOUND MACADAM SUB – BASE / BASE.

### 11.1.1. Scope.

This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary and water laid on properly backfilled pipeline and manhole trenches and finished in accordance with the requirements of these specifications and as directed by the Engineer.

The scope involves Providing, laying , spreading and compacting stone aggregates of specific sizes to Water Bound Macadam specification including spreading in uniform thickness, hand packing, rolling with 3 wheeled steel/vibratory roller 8-10 tones in stages to proper grade and camber, applying and brooming requisite type of screening/binding materials to fill up the interstices of coarse aggregates ,watering and compacting to the required density with all lead & lifts etc complete with the following two layers of materials each compacted to 75 mm thick,

(i). Materials (Refer table 400 - 7, 8 & 9) Using Screening Crushable type such as Moorum or Gravel Grading-II (Clause: 404 of MORT & H).

(ii).Material (Refer table 400 - 7, 8 & 9) Using Screening Crushable type such as Moorum or Gravel Grading-III (Clause: 404 of MORT & H).

### 11.1.2. Materials

**(a). Coarse aggregates -** Coarse aggregates shall be either crushed or broken stone, crushed slag, over burnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quality. Materials other than crushed or broken stone and crushed slag shall be used in sub-base courses only. If crushed gravel / shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 400-6. The type and size range of the aggregate shall be specified in the contract or shall be as specified by the engineer. If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part 5).

**(b). Crushed or broken stone** - The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and distinguished particles, dirt and other deleterious material.

** Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet condition in accordance with IS : 5640.

*** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

**(c). Crushed slag -** Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of crushed slag shall not be less than 11.2 KN per m3 and the percentage of glossy material shall not be more than 20. It should also comply with the following requirements:

**(d). Over-burnt brick aggregates -** Brick aggregates shall be made from over burnt bricks or brick bats and be free from dust and other objectionable and deleterious materials.

**(e). Grading requirement of coarse aggregates -** The coarse aggregates shall conform to one of the Grading given in Table 400 – 7 as specified, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

**Table 400 – 7, Grading requirements of coarse aggregates**

| Gradation | Size range | I.S. Sieve designation | Percent by weight passing |
|---|---|---|---|
| 1 | 90 mm to 45 mm | 125 mm | 100 |

| | | | |
|---|---|---|---|
| | | 90 mm | 90-100 |
| | | 63 mm | 25-60 |
| | | 45 mm | 0-15 |
| | | 22.4 mm | 0-5 |
| 2 | 63 to 45 mm | 90 mm | 100 |
| | | 63 mm | 90-100 |
| | | 53 mm | 25-75 |
| | | 45 mm | 0-15 |
| | | 22.4 mm | 0-5 |
| 3 | 53 to 22.4 mm | 63 mm | 100 |
| | | 53 mm | 95-100 |
| | | 45 mm | 65-90 |
| | | 22.4 mm | 0-10 |
| | | 11.2 mm | 0-5 |

Note: The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other grading i.e., 2 & 3, it shall be 75 mm.

**(f). Screenings** - Screenings to fill voids in the coarse aggregate shall generally consist of the screen material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as murrum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material are below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 per cent.

Screenings shall conform to the grading set forth in Table 400-8. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in Table 400 – 9. The table also gives the quantities of materials (loose) required for 10 m2 for sub-base base compacted thickness of 100/75 mm. The use of screenings shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites, etc. as they are likely to get crushed to a certain extent under rollers.

Table 400 – 8, Grading for screenings

| Grading classification | Size of screenings | IS Sieve designation | Per cent by weight passing the IS sieve |
|---|---|---|---|
| A | 13.2 mm | 13.2 mm | 100 |
| | | 11.2 mm | 95-100 |
| | | 5.6 mm | 15-35 |
| | | 180 mm | 0-10 |
| B | 11.2 mm | 11.2 mm | 100 |
| | | 5.6 mm | 90-100 |
| | | 180 mm | 15-35 |

**Table 400 – 9, Approximate quantities of coarse aggregates and screenings required for 100 / 75 mm compacted thickness of water bound macadam (wbm) sub-base / base course for 10 m2 area**

| Classification | Size Range | Compact thickness Loose Qty. | Screenings | | | |
|---|---|---|---|---|---|---|
| | | | Stone screening | | Crushable type such as murram or gravel | |
| | | | Grading classification and size | For WBM sub-base/ base course (loose Qty) | Grading classification and size | Loose Qty. |
| Grading-1 | 90mm to 45mm | 100 mm 1.21 to 1.43 m3 | Type A13.2 mm | 0.27 to 0.30 m3 | Not Uniform | 0.30 to 0.2 m3 |
| Grading - 2 | 63mm to 45 mm | 75 mm 0.91 to .7m3 | Type A 13.2 mm | 0.12 to 0.15 m3 | - do - | 0.22 to 0.24 m3 |
| - do - | - do - | - do - | Type B 11.2 mm | 0.20 to 0.22 m3 | - do - | - do - |

| | | | | | | |
|---|---|---|---|---|---|---|
| Grading-3 | 53mm<br>to<br>22.4 mm | - do - | - do - | 0.18 to 0.21 m3 | - do - | - do - |

**(g). Binding material -** Binding material to be used for water bound macadam as a filter material meant for preventing ravelling, shall comprise of a suitable material approved by the engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part 5).

The quantity of binding material where it is to be used will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06 – 0.09 m3 / 10m2 and 0.08 – 0.10 m3/ 10 m2 for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of Crushable type such as murrum or gravel.

### 11.1.3. Construction operations

**(a). Preparation of base -** The surface of the sub-grade /sub-base/base to the specified lines and cross fall (camber) shall be made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water. Any sub-base /base / surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course) to applicable clause of these specifications.

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided since it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the existing thin bituminous surface by cutting 50 mm x 50 mm furrows at an angle of 45 degrees to the centre line of the pavement at one meter intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

**(b). Inverted choke -** If water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) or coarse sand shall be spread on the prepared subgrade

before application of the aggregates is taken up. In case of a fine sand or silty or clayey subgrade, it is advisable to lay 100 mm insulating layer of screening or coarse sand on top of fine grained soil, the gradation of which will depend upon whether it is intended to act as a drainage layer as well. As a preferred alternative to inverted choke, appropriate geo-synthetics performing functions of separation and drainage may be used over the prepared subgrade as directed by the engineer. Section 700 shall be applicable for use of geo-synthetics.

**(c). Spreading coarse aggregates -** The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-grade/sub-base/base to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3, as specified in clause 11.1.2., Wherever possible, approved mechanical devices such as aggregates spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards. Aggregates placed at spread in one or more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved drawings.

The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

**(d). Rolling -** Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 KN capacity or tandem or vibratory rollers of 80 to 100 KN static weight. The type of roller to be used shall be approved by the engineer based on trial run. Except on super-elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/ edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired cross fall (camber) and grade. In no case shall the use of screenings be permitted to make up depressions.

Material which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

**(e). Application of screenings -** After the coarse aggregate has been rolled to as per above specification, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates.

The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling with mechanical brooms, hand-brooms or both. In no case screenings shall be applied fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate. The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day’s operation.

**(f). Sprinkling of water and grouting -** After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

In case of lime treated soil sub-base, construction of water bound macadam on top of it can cause excessive water to flow down to the lime treated sub-base before it has picked up enough strength (is still “green”) and thus cause damage to the sub-base layer. The laying of water bound macadam layer in such cases shall be done after the sub-base attains adequate strength, as directed by the engineer.

**(g). Application of binding material -** After the application of screenings in accordance with the above clause, the binding material where it is required to be

used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

**(h). Setting and drying -** After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set.

The engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface. The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

### 11.1.4. Reconstruction of defective macadam

The finished surface of water bound macadam shall conform to the tolerance of surface regularity as prescribed in the relevant IS standards. However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to sub-grade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re-compacted. In no case shall depressions be filled up with screenings or binding material.

### 11.1.5. Arrangement for traffic.

During the period of construction, the arrangement of traffic shall be done by the contractor in accordance with the applicable clause of this section.

### 11.1.6. Measurements for payment.

Water bound macadam shall be measured as finished work in position in cubic metres as per Bill of Quantities item of work.

## 11.2. PRIMING OF BASE COURSE WITH BITUMINOUS PRIMERS

### 11.2.1 Scope

This specification relates to the operation of priming an absorbent base course, preparatory to a subsequent bituminous treatment, through application of a low viscosity bituminous material by spraying. The specification is intended to indicate what is considered to be a good practice for priming and shall apply unless modified by special provisions to take into account any unusual conditions.

The scope involves, Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base of low porosity such as WBM including clearing of road

surface and spraying primer at the rate of 0.75 kg/sqm using mechanical means. As per MORTH specification clause No. 502 complete in all respects with all lead & lifts etc complete.

**11.2.2 Materials**

The bituminous primer to be used should be such that it can penetrate into the base course to perform its intended function.

**11.2.3. Types of primer**

Table 11.2.1 can be used as guidance for choice of primer on different types of surfaces.

Table 11.2.1 Guidelines for choice of primer

| Type of Surface | Emulsion | Cut-back | | Road tar |
|---|---|---|---|---|
| Low porosity | Not suitable | MC-0 | | RT-1 or RT-2 |
| Medium porosity | SS or MS | MC-1 orSC-1 | MC-2 or SC-2 | RT-2 or RT-3 |
| High porosity | MS | MC-3 or RC-1 | | RT-3 or RT-4 |

The primers shall conform to IS: 8887 – 1978 (for cationic emulsions), IS: 217-1961 (for cut-backs), and IS: 215-1981 (for road tars), as applicable.

**11.2.4.Viscosity**

For selecting the appropriate type of primer out of the materials indicated in Table 1, the atmospheric temperature during application should be given consideration. Also, within the range of viscosity specified, the primer for use may be selected keeping in view the level of porosity of the surface to be treated.

**11.2.5. Quantity of primer**

The primer shall be applied at the rate of 0.75 kg/sqm.

**11.2.6. Construction**

**a. Weather and seasonal limitations**

Cut-back and road tar primers shall not be applied on wet surface or during dust storm or when the weather is foggy or rainy. Bitumen emulsion can be applied on wet surface. However, emulsions shall not be applied during dust storm or when it is actually raining.

Atmospheric temperature during priming should be above 10° C.

**b. Equipment**

All equipment required for the execution of work should be in good working condition at site.

**c. Preparation of base course surface**

The base course surface to be primed shall be swept clean and free from dust. All loose materials and other foreign matter on the surface shall be removed completely, if necessary by using power blowers or sweepers.

Large irregularities, potholes, depressions, etc. shall be repaired prior to priming. Minor depressions may be ignored until the surface is primed. After which these might be patched with a suitable premixed material prior to the subsequent bituminous treatment.

The underlying surface shall be dry prior to priming. Except that in the case of bitumen emulsions, it may be desirable to dampen the surface slightly in order to obtain better penetration of the primer.

Pre-wetting should be done by water spraying, using equipment capable of uniform application of water over the entire surface. The spraying may be taken up 2 to 12 hours before priming, in such quantity that the surface during priming is damp but not saturated with water. Traffic shall be kept off the prepared areas prior to priming.

**d. Application of primer**

After the base to be primed has been prepared as described above, the primer shall be uniformly applied over the surface using mechanical sprayers. Rate of application of primer shall correspond to the quantities given in clause 11.2.5.

The spraying should preferably be carried out using sprayer mounted on distributor truck or with hand sprayer using mechanical pump. The use of hand-held containers such as watering cans, perforated buckets etc., is unacceptable and should not be permitted under any circumstances. Quantity should be checked periodically using Tray Coating Test or any other suitable means.

Temperature of application of primer should be high enough to permit the primer to be sprayed effectively through the jets of the spray bar and to cover the base course surface effectively.

**e. Curing**

The primed surface shall be allowed to cure fully. No traffic shall be allowed over the primed surface during this period and in any case not before 24 hours if the primer is a cut-back bitumen and 6 hours in the case of bitumen emulsion. Any pool of excess cut-back primer, which has not been completely absorbed by any part of the base course surface during the curing period, should be carefully swept over the adjacent surface, and then a light sand blotter course applied. The amount applied should be just sufficient to blot up the excess bitumen and prevent it being picked up under traffic. If an excess of bitumen residue is found on the primed surface after bitumen emulsion has broken, a very light sand dusting may be applied to soak up the surplus material.

All loose sand should be swept from the base course surface prior to any subsequent bituminous treatment.

**Tack Coat**

All specifications in the clause 11.2.6 shall apply to this item of work and the specific scope of work involves Providing and applying tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.375 kg/sqm on the prepared granular surface cleaned with mechanical broom such as WBM surface as per MORTH specification clause No. 503 complete in all respects with all lead & lifts etc complete for old surfaces at vertical and horizontal joints.

## 11.4. SPECIFICATIONS FOR SINGLE COAT BITUMINOUS SURFACE DRESSING (20MM THICK PRE-MIX BITUMINOUS SURFACING).

### 11.4.1. Scope.

This specification is intended to indicate what is considered to be good practice for construction of single coat bituminous surface dressing and shall apply unless modified by special provisions to take into account unusual conditions. The work specified consists of a wearing surface composed of a single application of bituminous material covered with one application of cover material of size as specified below, applied on a previously prepared base or pavement.

The specific scope involves, Providing, laying and rolling of open-graded premix surfacing of 20 mm thickness composed of 13.2 mm to 5.6 mm aggregates either using penetration grade bitumen 80/100 or cut-back or emulsion to required line, grade and level to serve as wearing course on a previously prepared base, including mixing in suitable plant, laying and rolling with a smooth wheeled roller 8-10 tonne capacity, finished to required level and grades. Mechanical method using Penetration grade Bitumen and HMP of appropriate capacity, as per MORTH specification No.511 complete in all respects. (Bitumen 1.46kg/sqmt. Metal = 0.027) with 40-60 TPH hot mix with all lead & lift etc complete.

**11.4.2. Materials**

**a. Bituminous materials -** The bituminous materials shall be of grade 80/100 or cut-back conforming to the requirements as specified and provided for in the proposal and satisfy the related specification, issued by the Indian Standards Institution (vide I.S.I Standards 73-1961,215-1961,217-1961 and 454-1961).

**b. Cover materials**

**(i). Generalrequirements** - The cover material shall consist of crushed stone, crushed slag crushed gravel (shingle) or other stones, as specified, and shall have clean, strong, durable, and fairly cubical fragments free from disintegrated pieces, salt, alkali, vegetable matter, dust and adherent coatings. The aggregate shall preferably be hydrophobic in nature and of low porosity.

**(ii). Physicalrequirements** - The aggregate shall satisfy the requirements given in Table 11.4.1.

**Table 11.4.1**

| Sl. No. | Property | Value | Method of test |
|---|---|---|---|
| 1 | Abrasion value, using Los Angeles machine or | Max. 35% | IS: 2386 (Part IV) |
| | Aggregate impact value | Max. 30% | - do - |
| 2 | Flakiness index | Max. 25% | IS: 2386 (Part I) |
| 3 | Stripping value | Max. 25% | IS: 6241 |
| 4 | Water absorption (except in case of slag) | Max. 1% | IS: 2386 (Part III) |
| 5 | Soundness: Loss with sodium sulphate – 5 cycles (in case of slag only) | Max. 12% | IS: 2386 (Part V) |
| 6 | Unit weight or bulk density (In case of slag only) | Min. 1120 kg per $m^3$ | IS: 2386 (Part III) |

Where all these conditions cannot be satisfied, it is left to the Engineer-in-charge to allow reasonable tolerances.

**Size** - The size of chippings to be used shall depend on whether the treatment is for the first coat or for the subsequent or renewal coat and shall be as

per the size specified below. For single application of the aggregate, it is desirable to keep the grading of the various sizes as specified in Table 11.4.2.

**Table 11.4.2**

| | Sieve designation nominal size of aggregate | specification |
|---|---|---|
| I | For surfacing water-bound macadam - first coat | 100 percent passing through 20 mm square mesh sieve and retained on 10 mm square mesh sieve |
| II | For subsequent or renewal coats 10 mm | 100 percent passing through 12.5 mm square mesh sieve and retained on 6.3 mm square mesh sieve. |
| Note – It is essential to sieve the aggregates through proper size sieves to ensure the size stipulated in the specifications. The sieve sizes indicated above are as per IS: 460 – 1962. | | |

### 11.4.3. Construction methods

**a. Weatherandseasonallimitations -** Preferably, the surface dressing work shall be carried on only when the atmospheric temperature in shade is 16°C or above. No bituminous material shall normally be applied when the surface or the cover material is damp, when the weather is foggy or rainy or during dust storm, except, in case of emulsions, the surface should be slightly damp.

**b. Equipment -** All equipment necessary for the proper construction of work shall be on the site of the work in good condition.

**c. Preparationofroadsurface -** The underlying course on which surface dressing is to be laid shall be prepared, shaped and conditioned to a uniform grade and section as specified. Any depressions or pot-holes shall be properly made up and thoroughly compacted sufficiently in advance. The defective parts should be clearly cut out and the patches of new material put in, and not put on the existing surface.

Where the existing surface shows signs of "fatting-up", such position should be rectified. It is important that the surface be dry and thoroughly cleaned immediately before applying the binder. The surface should be swept clean free of caked earth and other foreign matter cleaned first with hard brushes, then with softer brushes and finally blowing off with sacks or gunny bags to remove the fine

dust. The base shall be applied with Tack coat as per clause 11.4.uniformly preferably by a mechanical sprayer.

**d. Applicationofbituminousmaterial -** After the surface to be treated has been prepared, as specified above, bituminous material shall be sprayed uniformly over the dry surface preferably using mechanical sprayers. The binder shall be applied at a temperature appropriate to the type of binder and equipment used. The premix open graded surfacing consisting of aggregates 13.2mm to 5.60mm shall be applied to an uniform thickness as per applicable IS standards to get the final compacted thickness of 20mm.

**e. Rolling cover materials -** Immediately after the application of the cover materials as described, the entire surface shall be rolled with a 8 to 10 tonne smooth wheeled road roller. The rolling shall begin at the edge and proceed lengthwise, over the-area to be rolled lapping not less than one third of the roller tread and proceed towards the centre. When the centre is reached, the rolling shall then start at the opposite side and again proceed towards the centre. In the super-elevated portions, the rolling should proceed from the inner to the outer edge. While the rolling is in progress, additional aggregate shall be spread by hand in whatever quantities may be required to fill irregularities and to prevent picking up of the aggregate by the roller. Rolling shall be continued until the particles are firmly embedded in the bituminous materials and present a uniform closed surface. Excessive rolling which results in the crushing of the aggregate particles shall be avoided.

**f. Finishing -** The finished surface shall be uniform and conform to the lines, grades and typical cross sections shown in the specifications.

**g. Openingtotraffic -** When straight run bitumen or road tar is employed as the binder, the finished surface shall be thrown open to traffic on the following day but if in special circumstances, the road is required to be opened to traffic immediately after rolling, speed of the traffic shall be limited to 16 km per hour till the following day.

Where cutback bitumen and emulsion is employed, the finished surface shall be kept closed to the traffic until it has sufficiently cured to hold the cover aggregates in place.

Controlling of traffic shall be done by some suitable device, such as barricading and posting of watchmen, etc.

### 11.5. SEAL COAT.

The scope of work involves Providing and laying seal coat sealing the voids in bituminous surface laid to the specified levels, grade and cross fall using Type A seal coat as per MORTH specification clause No. 513 complete in all respects with all lead & lift etc complete.(Bitumen = 0.98 kg/sqmt. Metal =0.009).

11.6. SPECIFICATIONS FOR CONSTRUCTION OF CONCRETE ROADS

### 11.6.1. Scope

This is intended to indicate what is considered to be good practice for the construction of cement concrete road pavements, including preparation of the subgrade and sub -base underneath these pavements. This does not however cover the requirements of fully mechanized constructions.

The scope involves providing specified thickness of 1:3:6 proportion cement concrete as base course and specified thickness of 1:1.5:3 proportion cement concrete as wearing course as per approved construction drawings and specifications.

### 11.6.2 Materials

**a. Ordinary Portland Cement -** This should comply with the requirements of IS - 8112 with latest revisions (Specification for Ordinary Portland Cement)

**b. Aggregates**

**General -** Aggregates should comply with IS - 383 -1970 "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete (Second Revision)" with special reference to the additional requirements stipulated for use in road works excepting in the case of Los Angeles Abrasion Test limit.

The Los Angeles Abrasion Test limits shall be not more than 35 per cent and 50 per cent for concrete wearing course and sub -base course respectively. ln addition, the limits of deleterious material shall not exceed the requirements set out in IS - 515 - 1959 “Specification for Natural and Manufactured Aggregates for Use in Mass Concrete." Weathered rock should not be used. In order to make good concrete, it is important to avoid crushed aggregate of poor shape. Very angular, flaky, elongated or splintery aggregates give a harsh mix of low workability. Maximum size of aggregate should not exceed l/4$^{th}$ of the pavement slab thickness. In case of pavements having reinforcement, maximum size of aggregate should also not exceed l/4th of minimum clear spacing between reinforcing bars.

**c. Coarse aggregates**

**Continuousgrading-** Continuously graded coarse aggregate should be furnished in at least two separate sizes with separation at 20 mm I.S. sieve when combined material graded from 40 to 4.75 mm is specified, and at 25 mm I.S. sieve when combined material graded from 50 to 4.75 mm is specified.

**d. Fineaggregate** - Fine aggregate shall preferably be natural sand. Crushed stone sand may also be used satisfactorily in concrete. The fine aggregate shall conform to IS: 383 -1970, the permissible percentage passing limits on 300 and 150 -micron sieves shall be 15 -55 per cent and 0 -20 per cent respectively instead of 15 -50 percent and 0 -15 per cent as stipulated in IS Specification. Crushed sand is usually more angular in shape than naturally occurring sand, and for this reason may tend to make the mix a little harsher. In some cases, it may prove

advantageous to use a mixture of naturally occurring sand and crushed stone sand if the former is not obtained in adequate supply or where its grading is poor. Bulking due to presence of moisture in the fine aggregate should be accounted for when volumetric batching is employed.

**e. Water -** Water used in mixing or curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in clauses of IS: 456 -2000 "Code of Practice for Plain and Reinforced Concrete". Potable waters are generally considered satisfactory for mixing or curing.

**f. Dowelandtiebars -** Dowel and tie bars shall be plain round steel bars conforming to the requirements of IS: 432 -1966.

**g. Premoulded joint filler -** Premoulded joint filler shall be of the thickness shown on the drawings within a tolerance of ±1.5 mm. It shall be 25 mm less in depth than the thickness of the slab, within a tolerance of ±3 mm and of the full width between road forms. Holes to accommodate dowel bars shall be accurately bored or punched out. The joint filler shall comply with the requirements of IS: 1838 -1961 "Specification for Preformed Fillers for Expansion Joint in Concrete, Non -extruding and Resilient Type (Bitumen -impregnated Fiber)."

### 11.6.3. Watercontentandworkability

The water content per batch of concrete should be maintained constantly except for suitable allowances to be made for free moisture and absorption by aggregates determined from time to time during construction. Adjustments for workability shall be made by variations in the ratio of the coarse to fine aggregate or improving upon their grading without change in cement content or water -cement ratio. The slump of the concrete mix for pavements compacted by vibration should not be more than 25 mm, preferably between 0 and 12 mm, and that by manual compaction not more than 50 mm. No price adjustment would be permissible for variations in the gradations of the aggregates or in the ratio of coarse to fine aggregates necessitated from adjustment at site.

### 11.6.4.Tools,equipmentandappliances

#### General

All tools, equipment and appliances necessary for proper preparation of sub-grade, laying of sub -base and batching, mixing, placing, finishing and curing of concrete shall be at the project site in good working condition and shall have been inspected by the engineer before the paving operations are permitted to start. Throughout the construction of the project, the construction agency shall maintain all necessary tools, equipment and appliances in first class working condition to ensure proper execution of the work. Arrangements shall also be made for requisite number of stand -by units in the event of break -downs during construction.

### 11.6.4.1. Listoftools,equipmentandappliances

A list of tools, equipment and appliances required for the different phases of concrete road construction is given below.

This list pertains to semi -mechanised type of construction only, as practised most in this country.

**(a) Subgrade and sub -base compaction -**

(i) Compaction equipment (three wheeled or tandem roller, pneumatic roller, vibratory roller or sheep -foot roller)

(ii) Watering devices (water lorries, bhisties/water carriers or watering cans),

**(b) Preparation of sub -bass for concreting and formwork**

(i) Scratch templates or strike boards

(ii) Bulk -heads

(iii) Pick axes, shovels and spades

(iv) Formwork and iron stakes

**(c) Concrete manufacture**

(i) Shovels and spades

(ii) Sieving screens

(iii) Weigh batcher

(iv) Aggregate measuring boxes (only where volume batching of aggregates is permitted as a special case)

(v) Water pump

(vi) Water measures

(vii) Concrete mixer

**(d) Transportation, laying and compaction of concrete**

(i) Wheel barrows/iron pans

(ii) Wooden bridges

(iii) Spades

(iv) Concrete vibrators (both internal and screed board types)

(v) Wooden hand tampers

**(e) Finishing operations - surface and joints**

(i) Wooden bridges

(ii) Floats (longitudinal and long -handled wooden floats)

(iii) Templates

(iv) Three -meter long straight edges including one master straight edge

(v) Graduated wedge gauges

(vi) Mild steel sections and blocks for making joint grooves

(vii) Edging tools including double -edging tools

(viii) Canvas belts

(ix) Long handled brooms

(x) Diamond cutter (when making saw -cut joints)

(xi) Grinder (for grinding local high spots)

**(f) Curing**

(i) Hessian cloth burlap or polyethylene sheeting

(ii) Watering devices as in a (ii) (for ponding operation)

**(g) Cleaning and sealing of joints**

(i) Iron raker

(ii) Coir brush

(iii) Cycle pump/pneumatic air blower

(iv) Kerosene stove

(v) Thermometer

(vi) Transferring pot

(vii) Painter's brush

(viii) Pouring kettle

(ix) Scraper

### 11.6.5. Sub –base

Plain cement concrete of 1:3:6 proportion for specified thickness as in construction drawing shall be laid in accordance with the respective specification in

Bill of Quantities and the surface finished to the required lines, levels and cross -section.

### 11.6.6. Forms

**Steel forms -** All side forms shall be of mild steel unless use of wooden sections is specially permitted. The steel forms shall be mild steel channel sections of depth equal to the thickness of the pavement. The sections shall have a length of at least 3 m except on curves of less than 45 m radius, where shorter sections may be used. When set to grade and staked in place, the maximum deviation of the top surface of any section from a straight line shall not exceed 3 mm in the vertical plane and 5 mm in the horizontal plane. The method of connection between sections shall be such that the joint formed shall be free from difference in level, play or movement in any direction. The use of bent, twisted or worn -out forms will not be permitted. At least three stake pockets for bracing pins or stakes shall be provided for each 3 m of form and the bracing and support must be ample to prevent springing of the forms under the pressure of concrete or the weight or thrust of machinery operating on the forms.

The supply of forms shall be sufficient to permit their remaining in place for 12 hours after the concrete has been placed, or longer if necessary in the opinion of the engineer.

**Wooden forms -** Wooden forms may be used only when specifically permitted in the drawing with the exception that their use is herein approved for all curves having radii of less than 45 m. Wooden forms shall be dressed on one side. They shall have minimum base width of 100 mm for slab thickness up to 200 mm and a minimum base width of 150 mm for slabs over 200 mm thick. Their depth shall be equal to the thickness of the pavement. These forms when used on straight shall have a minimum length of 3 m. Forms shall be held by stakes set at intervals not exceeding 2 m. Two stakes, one on each side, shall be placed at each joint. The forms shall be firmly nailed or secured to the side stakes, and securely braced at joints, where necessary, so that no movement will result from the pressure of the concrete or the impact of the tamper and during finishing work. Wooden forms shall be capped along the inside upper edge with 50 -mm angle iron well recessed and kept flush with the face of the wooden forms.

**Settingofforms -** The forms shall be jointed neatly and shall be set with exactness to the required grade and alignment. Both before and after the forms are placed and set the sub grade or sub -base under the forms shall be thoroughly tamped in an approved manner. Sufficient rigidity shall be obtained to support the forms in such a position that during the entire operation of compacting and finishing of concrete they shall not at any time deviate more than 3 mm from a straight edge 3 m in length. Forms, which show a variation from the required rigidity or alignment and levels shown in the drawing, shall be reset or removed, as directed. The length and number of stakes shall be such as to maintain the forms at the correct line and grad -e. All forms shall be cleaned and oiled each time

before they are used. Forms shall be set for about 200m ahead of the actual placing of concrete.

### 11.6.7. Joints

**General -** The location and type of joints shall be as shown in the drawing. The edge of the slab at all joints shall be rounded off with an edging tool having a radius of 6 ± 1mm. The concrete along the face of all joints and around all tie bars and dowels shall be compacted with an internal vibrator inserted in the concrete and worked along the joint and around all tie bars and dowels to ensure a concrete free from honeycombing.

**Types of joints -** There are three general types of joints. These are –

**(i) Expansion joint** - Such joint provides the space into which pavement can expand thus relieving compressive stresses due to expansion and inhibiting any tendency towards buckling of concrete slabs.

**(ii) Contraction joint** - Such joint relieves tensile stresses in the concrete and prevents formation of irregular cracks due to restraint in free contraction of concrete. Contraction joints also relieve stresses due to warping.

**(iii) Warping joint** - Such joint relieves stresses due to warping. These are commonly used for longitudinal joints dividing the pavement into lanes.

In addition, construction joints are provided whenever construction operations require them. These are full depth joints and may belong to any of the above types.

All joints shall be carefully installed in accordance with the location and details given on the plans. The details of different types of joints are shown in Appendix B.

**Transversejoints**

**General** - Transverse joints can be expansion, contraction or construction joints and shall be placed as indicated on the drawing. They shall make a right angle with the centre line of the pavement and surface of the sub -base/subgrade. Contraction and expansion joints shall be continuous from edge to edge of the pavement through all lanes constructed at the same or different times.

**a. Transverseexpansionjoints -** These shall extend over the entire width of the pavement. They shall be of the dimensions and spacing as shown on the construction drawing.

Dowel bars (see Supplementary Note N. 4) as per dimensions, location and spacing shown on the drawing are required at expansion joints to transfer wheel loads to the adjacent slab. For slabs of thickness less than 150 mm no dowel bars may be provided (IS: 6509 -1972). The pre-moulded expansion joint filler, a

compressible material used to fill the gap between adjacent slabs at expansion joint shall conform to IS: 1838 -1961.

The height of the filler board shall be such that its top is 25 mm below the surface of the pavement. The dowel bars shall be held accurately in position during the placement, compaction and finishing of concrete at and near the expansion joint. This and the protection of the joint groove during construction may be achieved by means of sufficiently strong bulkheads (as per IRC: 43 -1972) with holes drilled along the centre line to accommodate the dowel bars and a mild steel section (as per IRC - 43 -1972) respectively. The latter shall be oiled or greased before placing in position to avoid bonding with concrete. The top and bottom edges of the bulkheads and mild steel section shall be shaped to correspond to the camber of the pavement at the joint. If considered convenient, two -piece split bulkheads may also be used. When dowel bars are provided, bulkheads shall be used in pairs, one at the joint location, and the other some distance away to hold the projecting ends of the dowel bars to maintain their alignment. For cases where dowel bars are not provided, one single bulkhead without holes will be adequate.

The bulkheads shall be securely staked in place at right angles to the centre line and surface of the pavement with sufficient stakes to hold them in the specified position.

After the concrete has sufficiently hardened the mild steel metal section shall be removed carefully without disturbing the edges. The edges shall then be rounded with an edging tool. For facilitating removal of the mild steel section as well as edging operation, the top of the section may be flared on both sides with the required curvature of a rounded edge.

Under no circumstances shall any concrete be left above the expansion 'joint filler or across the joint at any point. Any concrete spanning the ends of the joint next to the forms shall be carefully cut away after the forms are removed.

**b. Transversecontractionjoints -** These shall be placed as shown on the drawing and shall be of the weakened plane or "dummy" groove type. They shall be constructed by forming in the surface of the slab a slot not less than 6 mm wide and having a depth equal to one -third to one -fourth the depth of the pavement at the thinnest part of its section. This slot may be formed in a manner approved by the engineer such as by pushing into the concrete a flat bar or the web of a "T" bar using a suitable vibratory device, removing the bar, and keeping the slot open. It shall be ensured that no spalling of concrete occurs while removing the bar. The edges of the joint shall be rounded with an edging tool before the concrete hardens.

**c. Transverse construction joints -** These shall be placed whenever placing of concrete is suspended for more than 30 minutes. Excepting in the case of emergency, construction shall always be suspended at the regular site of

expansion or contraction joints. If the construction joint is located at the site of an expansion joint, regular expansion joint shall be provided; if at the site of a contraction joint or otherwise, the construction joint shall be of butt type with dowels.

At all construction joints, bulkhead shall be used to retain the concrete and care shall be taken in striking off and finishing the surface to the top face of the bulkhead. When work is resumed, the surface of concrete laid subsequently, shall conform to the grade and cross -section of previously laid pavement, and a straight edge 3m in length shall be used parallel to the centre line, to check any deviation in the surface of the two sections. Any deviation from the general surface in excess of 3 mm shall be corrected.

**Longitudinaljoints**

These shall be of the plain butt type and shall be formed by placing the concrete against the face of the slab concreted earlier. The face of the slab concreted earlier, shall be painted with bitumen before placing of fresh concrete.

Tie bars shall be used at longitudinal joints and they shall be of the dimensions and at spacing shown in the construction drawing. Tie bars shall be supported so as not to be displaced during construction operations. Tie bars shall be bonded in the slabs across longitudinal joints, and whilst casting the first slabs, they may be bent so that one end of them lies along the forms. After removal of the forms, bars shall be straightened so that they extend into the concrete placed on the other side of the joint.

**11.6.10.Construction**

**a. Storageandhandlingofcement**

Cement shall not be stored for a long time and should be used normally within six months of its date of receipt. Even during this period of storage it is essential that cement shall be protected from moisture by storing it in suitable sheds. Storage shed with a concrete floor laid on a well -drained foundation may be satisfactory. Cement in bags shall be stored on boards raised above the floor level for the purpose of ventilation, and the bags shall not touch the walls of the shed. Different consignments should be separately stacked and used in order in which they have been received. When bulk supply cement is used, special storage facilities such as covered hopper bins will be required. Supply of cement should be co-coordinated with its consumption so that it is not stored right through the rainy season, when normally concreting is discontinued. Cement having lumps which have been caused due to improper storage or by pressure due to over -loading of bags shall not be considered for use unless these lumps can be easily powdered with pressure between fingers. Before such cement is used, representative sample containing also the lumps in fair proportion shall be taken and tested as per IS - 269 -1976, 8112 -1976, 1489 -1976, 455 -1967 or 8041E -1976 as the case my be, to fulfill the minimum requirements.

**b.Storageandhandlingofaggregates**

The location and preparation of sites, minimum size of stack and the methods adopted for dumping and stacking to prevent segregation of coarse and fine material shall be subject to the approval of the engineer. Aggregates from different sources and/or of different grading shall not be stacked together. Each separate size of coarse aggregate shall be stacked separately. The storing of aggregates upon the carriageway or shoulders shall not be permitted.

If aggregates are stored in conical stacks, segregation will be increased by the rolling of the coarser particles down the sides of the stacks. To avoid this, stacks should be built up in approximately horizontal layers. Dry fine aggregate segregates and gets blown away easily it may be helpful to moisten it.

To assist in controlling the water/cement ratio, large fluctuations in the moisture content of aggregates may be reduced by storing the bulk of the material well in advance of use. For this purpose, all washed aggregates shall be stacked for draining at least 12 hours before being batched. It is also a good practice to reserve the bottom 150 -300 mm or so of the stacks as a drainage layer. Where this cannot be done, the aggregates should not be placed on the ground. In such case, somewhat raised planks, metal sheets or concrete base should be provided and laid to slopes.

The aggregates shall be handled from the stacks and fed into the mixer in such a manner as to secure the stipulated grading of the material. Aggregates that have become mixed with earth or other foreign material shall not be used. They shall be washed clean before use.

**c. Batchingofmaterials**

All batching of materials shall be by weight or volume as approved by the Engineer. the proportion of ingredients shall be as specified in the item of work in Bill of Quantities, The Engineer may permit the use of fractional bags of cement provided they are accurately weighed and are handled in a manner meeting with his approval. Water may be measured by volume. It should, however, be borne in mind that weigh batching is definitely much more desirable than volume batching. If batching by volume is permitted, as a special case, separate measuring boxes shall be provided for the different aggregates. The boxes shall be of strong construction provided with handles for convenient lifting and loading into the mixer. They shall be of such size that it should be possible to measure out the requisite quantity of aggregate per batch in whole box or by multiples thereof and capable of being lifted by two men. Each box shall be provided with a straight edge of required length for striking off after filling. If so directed by the engineer, improved facilities such as tipping boxes of accurate capacity working on run -out rails arranged for direct delivery into the hopper of the mixer shall be provided by the construction agency. In volume batching, suitable allowance shall be made for the hulking of fine aggregate due to the presence of water. For this purpose the bulking shall be determined as per relevant Indian Standard Specification.

**d. Mixing**

**General** - The mixing of concrete shall be done in a batch mixer of approved type, which will ensure a uniform distribution of materials throughout the mass, so that the mix is uniform in colour and homogeneous. All concrete shall be mixed in quantities for immediate use.

The mixer shall be equipped with approved water -measuring device capable of accurate measurement of water required per batch. The mixer shall preferably be equipped with a mechanically operated pump for filling the mixer tank.

The mixer, if so specified, shall be equipped with an approved timing device which will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period; the device shall also be equipped with a ball, adjusted to ring each time the lock is released. If the timing device gets broken, the mixer will be permitted to be used while the same is being repaired, provided an approved time -piece equipped with minute and second bands is provided. Each batch shall be mixed for at least one and a half minutes. Spilling of the materials at either end of the mixer shall be corrected by reducing the size of the batch and in no case shall the volume of the mixed material per batch exceed the manufacturers guaranteed capacity of the mixer. The type, size and number of mixers shall be so chosen as to provide the required output without overloading. The mixing speed of the drum shall not be less than 15 revolutions per minute nor the peripheral speed of the drum greater than 60 m per minute. The batch of cement, fine aggregate and coarse aggregate shall be fed into the mixer simultaneously with the water being introduced either at the same time or before the dry materials. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

The skip shall be so maintained and operated that each batch will be completely discharged into the mixing drum at the loading of the mixer. The mixer shall be cleaned at suitable intervals while in use.

Pick -up and throw -over blades in the drum of the miner which are worn down 20 mm or more in depth shall be replaced with new blades.

**(i). Timeofmixing -** The mixing of each batch will continue not less than one and half minute after all the materials are discharged into the mixer.

**(ii). Re-tempering** - The re-tempering of concrete i.e. remixing with or without additional cement, aggregate or water shall not be permitted.

**11.6.11. Controlofworkabilityandstrength**

**a. Workabilityofconcrete** - The workability of concrete shall be checked by performing "slump test" or "compacting factor test" in accordance with IS ; 1199 -1959 “Method of Sampling and Analysis of Concrete." The frequency of testing shall be one test per 10 m3 of concrete and the permissible tolerances from the specified value for workability shall be -

| | |
|---|---|
| Slump | ± 12 mm |
| Compacting factor | ± 0.03 |

Where variations beyond the permitted tolerances are observed, necessary adjustment shall be made keeping the water cement ratio same.

**b. Strengthofconcrete -** The strength of concrete shall be determined either by compressive or flexural strength tests (preferably the latter, since concrete pavements are designed on the basis of flexural strength of concrete) depending on the facilities available. For this purpose, during the progress of the work, cube/beam samples shall be cast for testing at 7 and 28 days. Sampling and testing shall be done in accordance with IS - 1199 -1959 “Method of Sampling and Analysis of Concrete" and IS - 516 -1959 "Method of Test for Strength of Concrete" respectively. The minimum frequency of samples shall be 3 cube/beam samples for each age of 7 and 28 days for every 30 m3 of concrete.

On a paving job, the strength of concrete should be continuously monitored to ensure that the desired strength is achieved. In certain -cases, because of change in the source of cement or control or climatic factors, the strength may show some variations, which would require re -designing of the mix.

**11.6.12. Transportingandplacingofconcrete -** The concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub - base to the required depth and width of the pavement section, in successive batches and in continuous operation without the use of intermediate forms or bulk - heads between joints. Care shall be taken to see that no segregation of materials results whilst the concrete is being transported from the mixer to the place where it is deposited. The usual method of transport of concrete in India is in pans as head loads or in small wheel barrows. The spreading shall be as uniform as possible to avoid re-handling of the concrete. Where, however, a certain amount of re - distribution is necessary, it shall be done with shovels and not with rakes. While being placed, the concrete shall be tamped with suitable tools for slab thicknesses of 12.5 cm and less so that formation of voids or honeycomb pockets is prevented. The concrete shall be particularly well placed and tapped against the forms and along all joints, For higher thicknesses an internal vibrator shall be employed in lieu of rodding of the concrete. To effect adequate compaction, the concrete shall be placed with appropriate surcharge over the final slab thickness. The amount of surcharge will depend on the mode of placement of concrete and shall be determined by trial. In general, the required surcharge is about 20 per cent of the required slab thickness. Any portion of the batch of concrete that becomes segregated while depositing it on sub-grade shall be thoroughly mixed with the main body of the batch during the process of spreading. In case of unavoidable interruption, a full depth transverse joint shall be made at the point of stoppage of work provided the section on which the work has been suspended is about 2 to 3 hours long. In placing of concrete for two course construction, necessitated by either positioning of the reinforcement, a richer mix for the wearing surface, or when thickness of the concrete is beyond 20 cm, the bottom layer of concrete shall

be struck off to the required levels by a vibrating screed working on the side forms with notches corresponding to the depth of the top course of concrete.

The vibrating screed should have a vibrating unit mounted on it similar to that of the screed used for compaction of the final surface of concrete. The time lag between laying of the two courses shall not exceed the initial setting time of cement.

**11.6.13. Placementofsteel**

**a. Reinforcement -** Reinforcing steel shall be free from dirt, scale or other foreign matter and rust of such degree or development as to impair bond of the steel with the concrete. The width of fabric sheets or bar mats shall be such that when properly placed into the work the extreme longitudinal bars or wires of the sheets or mats will be located not less than 50 mm and not more than 100 mm from the edges of the slab. Except for dummy joints, the length of fabric sheets or bar mats shall be such that when properly placed into the work, the reinforcement will be clear of transverse joints by not less than 50 mm and not more than 100 mm as measured from the centre of the Joint to the ends of longitudinal bars or wires of the sheet or mat.

While overlapping the sheets or mats in either direction, the overlap shall be at least equal to the spacing between the bars or wires in the respective direction or 40 times the diameter of the bar or wire, whichever is more.

Whilst using reinforcement in one layer, the concrete shall be placed in two stages. The initial layer shall be uniformly struck off to a depth corresponding to the reinforcement shown in the drawings and lightly compacted by a screed to obtain uniform levels. The reinforcing fabric sheet or bar mat shall then be placed on the compacted layer of concrete and remaining depth shall be filled in with concrete thereafter.

In doing this operation, the initial layer of concrete shall be struck off to the entire width of the slabs and of sufficient length to permit sheet or mat of reinforcement to be laid full length without further manipulations of the reinforcement. Displacement of the reinforcement during concreting operations shall be prevented.

**b. Loadtransferdevices - dowels -** Transverse expansion joints shall be equipped with dowels of the dimension and at the spacing and location indicated on the drawing. They shall be firmly supported in place, accurately aligned parallel to the sub-grade/sub -base, parallel to each other and parallel to the centre line of the pavement, by means of appropriate dowel supports. The dowel supports shall ensure that the dowels are not displaced during construction. The permissible tolerances in dowel bar alignment in both vertical and horizontal directions shall be $\pm$1 mm in 100 mm for dowels of 20 mm and smaller diameters and $\pm$0.5 mm in 100 mm for. dowels of diameter greater than 20 mm. One -half of each dowel shall be painted with a thin film of bitumen and equipped with a tight fitting

metal sleeve of the dimensions shown on the drawing to provide space for the dowel when pavement expands and the join closes. This sleeve shall be partly filled with cotton waste to prevent it being pushed too far on the dowel during construction.

These sleeves are not required on dowels, if used, in dummy contraction or construction joints.

**c. Tiebars -** Tie bars provided in longitudinal joints of plain butt type to prevent opening of such joints shall be bonded to the adjacent slabs on both sides of the longitudinal joint. They are installed by providing appropriate (drilled) holes in the side forms depending on the size and spacing of bars. They are bent aside temporarily to avoid obstruction to construction traffic and straightened later at the time of laying of slab in the adjacent lane.

**11.6.14. Compactionandfinishing**

**11.6.14.1 Compaction -** The pavement shall be compacted either by means of a power-driven pavers-cum -finisher or by a vibrating screed along with internal vibrators where the slab thickness is more than 12.5 cm. For lesser thicknesses vibrating screed may be supplemented with manual rodding. For areas where the width of the slab is very small as at the corner of street junctions, etc. compaction with wooden hand tampers may be adopted subject to the approval of the engineer. In no case, however, hand compaction shall be permitted for slab thicknesses beyond 10 cm. All compaction shall be done in accordance with the following requirements –

**(i) Where hand tamping is permitted as a special case –**

(i) Concrete with surcharge, as soon as placed, shall be struck off uniformly and screeded, to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross -section indicated by the plans. The entire surface shall then be tamped and the tamping operation continued until a close knit dense surface is obtained.

(ii) The tamper shall rest on the side forms and shall be drawn ahead with a sawing motion, in combination with a series of lifts and drops alternating with lateral shifts, the aim of this operation being compaction and screeding to the approximate level required. Subsequent tamping should advance about 75 mm at a time in the direction in which the work is proceeding, and in the final stages tamping should be closer, about 12 mm at a time until a level and dense surface is obtained.

(iii) Segregated particles of coarse aggregate which collect in front of the tamper or screed shall be thrown outside the forms or thoroughly mixed by hand with the un compacted mass of concrete already placed. Under no circumstances shall such segregate particles be carried forward and pushed on to the base in front of the mass.

(iv) Compaction by tamping or screeding shall be carried on till the mortar in the mix just works up to the surface. Care shall be exercised and the operation of tamping so controlled as to prevent an excess of mortar and water from being worked on to the top. Repeated operation other than to secure the necessary compaction and to eliminate voids shall be avoided.

(v) Immediately after the tamping or screeding has been completed and before the concrete has hardened, While the concrete is still in a plastic stage, the surface shall be inspected for irregularities with a profile checking template and any needed correction made by adding or removing concrete followed by further compaction and finishing.

**11.6.14.2. Floating -** As soon as practicable after the concrete has been compacted, its surface shall be smoothened by means of a longitudinal float, operated from a foot -bridge. The longitudinal float shall be worked with a sawing motion, while held in a floating position parallel to the carriageway centre line and passed gradually from one side of the pavement to the other. Movements ahead along the centre line of the carriageway shall be in successive advances of not more than one half the length of the float.

**11.6.14.3. Straight-edging** - After the longitudinal floating has been completed and excess water has disappeared, but while the concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. The straight edge shall be held in successive positions parallel to the road centre line in contact with the surface and the whole area gone over from one side of the slab to the other. Advance along the road shall be in successive stages of not more than one -half length of the straight edge. Any area of depression found shall be scooped to a depth of 4 -5 cm, filled immediately with freshly mixed concrete, struck, compacted, and re-finished. High areas shall be cut down and refinished. The straight edging and re-floating shall continue until the entire surface is found to be free from observable departures from the straight edge and the slab has the required grade and camber.

The slab surface shall be retested for trueness, before the concrete begins to set, with the 3 m long master straight edge and the graduated wedge gauge.

The straight edge shall be placed on the surface in successive positions, parallel to the carriageway centre line. Irregularities shall be measured with the help of the wedge gauge moved transversely at various points until it touches both the straight edge and the concrete surface.

At any point tested the concrete shall not show a departure greater than 3 mm from the true surface. If at any place the departure exceeds this value not more than 3 passes of the vibrating screed shall be allowed and the surface tested again in the specified manner. If the irregularity still exceeds the limit aforesaid, the concrete shall be removed to a depth of 50 mm or up to the top surface of the reinforcement, if any. The area of concrete to be removed shall be

demarcated by the length of the straight edge in the position of measurement across the full width of the slab. Where the point of measurement in default is less than 4.5m from the nearest transverse expansion joint, the whole area upto the joint shall be removed to the required depth. The concrete so removed shall not be re -used in the carriageway. Fresh concrete shall be placed, compacted and finished in the manner already described in these specifications and shall again be subject to test for accuracy of finish.

The foregoing procedure shall be adopted at each shifting of the straight edge and the whole area shall be gone over from one side of the slab to the other. The straight edge shall advance longitudinally in successive stages of not more than one -half the length of the straight edge.

No extra payment shall be made for the removal of the rejected concrete and or laying fresh concrete.

Although the concrete may be removed immediately following measurement of the irregularity and while it is still wet, this shall not mean any waiver from complying with the requirements of this clause, if for any reason the concrete to be removed has already hardened.

After straight edging of the surface, it shall be finished by brooming in the manner described as mentioned in the following paragraphs.

**11.6.14.4.Brooming -** After belting and as soon as surplus water if any has risen to the surface, the pavement shall be given a broom finish with an approved long handled steel or fiber broom conforming to the stipulations laid down in JRC - 43 -1972. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be' perpendicular to the centre line of the pavement and so executed that the corrugations thus produced will be uniform in character and width, and about 5mm deep. Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions and small pockets, such as may be caused by accidentally disturbing the particles of coarse aggregate embedded near the surface.

**11.6.15. Curing of concrete -** Immediately after the finishing operations have been completed the entire surface of the newly laid concrete shall be covered against rapid drying, and cured. Failure to provide sufficient cover material of the stipulated type or inadequate supplies of water for curing shall be adequate cause for immediate suspension of concreting operations.

**11.6.15.1. Initialcuring -** After completion of the finishing operations, the surface of the pavement shall be entirely covered with wet hessian cloth, burlap or jute mats. The coverings used shall be of such length (or width) that when laid will extend at least 500 mm beyond the edges of the slab, shall be so placed that the

entire surface and both the edges of the slab are completely covered. They shall be placed as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to their being placed, the coverings shall be thoroughly wetted with water and placed with the wettest side down. They shall be so weighed down as to cause them to remain in intimate contact with the surface covered. They shall be maintained fully wetted and in position for 24 hours after the concrete has been placed, or until the concrete is sufficiently hard to be walked upon without suffering any damage. To maintain the coverings wet, water shall be gently sprayed so as to avoid damage to the fresh concrete. If it becomes necessary to remove the coverings for any reason, the concrete slab shall not be kept exposed for a period of more than half an hour.

Worn coverings or coverings with holes shall not be permitted. Coverings reclaimed from previous use other than curing concrete shall be thoroughly washed prior to use 'for curing purposes, if the covering is furnished in strips, the strips shall be laid to overlap at least 150 mm.

Covering shall be placed from suitable wooden bridges (IRC -43 - 1972). Walking on freshly laid concrete to facilitate placing coverings shall not be permitted.

**11.6.15.2. Finalcuring-** Upon the removal of the covering the slab shall be thoroughly wetted and then cured by one of the following methods of final curing -

**(a) Curing with wet earth** - Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal dykes of clay about 50 mm high, covered with a blanket of sandy soil free from stones to prevent the drying up and cracking of clay. The rest of the slab shall then be covered with sufficient sandy soil so as to produce a blanket of earth not less than 40 mm depth after wetting. The earth covering shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 14 days and thoroughly wetted down during the morning of the 15th day and shall thereafter remain in place until the concrete has attained the required strength and permission is given to open the pavement to traffic. When such permission is granted, the covering shall be removed and the pavement swept clean. If the earth covering becomes displaced during the curing period, it shall be replaced to the original depth and re - saturated,

**11.6.16.Removingforms -** Forms shall not be removed from freshly placed concrete until it has set, or at least 12 hours, whichever is later. They shall be carefully removed in such a manner that no damage is done to the edges of the pavement. After the forms have been removed, the slab edges shall be cleaned and any limited honey -combed areas pointed up with 1 -2 cement sand mortar, after which the sides of the slab shall be covered with earth to the level of the top of the slab for final curing Slabs with excessive honey -combing as a result of inadequate compaction shall be removed between nearest transverse joints.

**11.6.17. Concretingduringmonsoonmonths -** When concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulins or other waterproof cloth shall be provided along the line of work. Any time when it rains, all freshly laid concrete, which has not been covered for curing purposes, shall be adequately protected by means of tarpaulins or other waterproof cloth. Any concrete damaged by rain shall be removed and replaced.

**11.6.18. Concretinginhotweather -** As placing of concrete in air temperatures above 40°C, or above 35°C combined with relative humidity below 25 percent and/or wind velocity higher than 10 km/hour, is attended with defects like loss of workability through accelerated setting, formation of plastic shrinkage cracks, etc., it is recommended that unless adequate precautions are taken, no concreting shall be done in conditions more severe than the above. The procedures recommended for adoption in case of hot weather concreting is given in IRC - 61 -1976 “Tentative Guidelines for the Construction of Cement Concrete Pavements in Hot Weather." Brief details of the procedure are given below - Aggregates, cement and water shall be protected from the direct sun and mixing operations shall also be carried out in shade. In addition portable shelters shall be provided to protect the concrete during placing and finishing operations. This may be in the form of gable frames to cover the full length of the concrete pavement laid in a day. The surfaces of the formwork and subgrade coming in contact with concrete shall be moistened prior to placing of the concrete to prevent absorption of mixing water.

Since the setting time of concrete is considerably reduced under such temperatures, labour force shall be reinforced to minimise the time between mixing and placing of concrete. The protective cover shall be adequate to exclude exposure of the concrete directly to the sun and also eliminate contact with drying winds. Prior to removal of the portable shelters, the hardened concrete shall be covered with wet hessian or burlap or the like followed by one of the usual methods of curing like ponding, etc. In addition, the moist curing period shall be extended to 4 weeks.

**11.6.19. Workongradients -** The progress on gradient of all operations of placing, compacting and finishing of concrete should proceed from the lower to the higher reaches. The concrete mix shall be stiffer than that used on level reaches.

**11.6.20. Protection of concrete -** Suitable barricades shall be erected and maintained and watchmen employed to exclude traffic from the newly constructed pavement for the period herein prescribed, and these barriers shall be so arranged as not in any way to interfere with or impede traffic on any lane intended to be kept open and necessary signs and lights shall be maintained clearly indicating any lanes open to the traffic. Where, as shown on the plans or indicated in the special provisions, it is necessary to provide for traffic across the pavement, suitable and substantial crossings to bridge over the concrete shall have to be provided. Such crossings, as constructed, shall be adequate for the traffic and approved by the Engineer.

Any part of the pavement damaged by traffic or other causes occurring prior to its final acceptance shall be repaired or replaced in a manner satisfactory to the Engineer. The pavement shall be protected against all traffic usage including that of construction -traffic.

**11.6.21. Sealing of joints -** After the curing period is over and before the pavement is opened to traffic, the temporary seal and all other intruded materials in the transverse expansion and contraction joints as well as longitudinal joints shall be removed completely and the groove; filled with the approved joint sealing compound as per IRC - 57 -1974 "Recommended Practice for Sealing of Joints in Concrete Pavements". The joint opening shall be thoroughly cleared of all foreign matter before the primer followed by sealing material is placed. If necessary, the foreign matter shall be blown out by compressed air pressure. All contact faces of the joint shall be cleaned with a wire brush to remove loose material and shall be surface dried before the primer is applied.

**11.6.22. Openingtotraffic -** In general, traffic shall be excluded from the newly constructed pavement for a period of 28 days where Ordinary Portland Cement, Portland Blast Furnace Slag Cement and Portland Pozzolona Cement are used, or for a period of 7 days where Rapid Hardening Cement is used. In all cases, before the pavement is opened to traffic it shall be cleaned and the joints shall be sealed.

## 12.0 General Civil Specifications:

The following civil specifications shall be applicable for providing and executing all such items which are not mentioned in foregoing paras but are necessary to be provided and for the items in bill of quantities which are mentioned above but require some elaboration. No extra cost shall be paid for such items. It should clearly be understood by the Contractors / tendering firms that all civil specifications mentioned here below shall be treated as part of the technical specifications already mentioned. The specific requirement of different items of work involved in the construction, completion and commissioning of the system as a whole, shall be provided in accordance with the requirement given in these civil specifications.

### 12.1. Site Clearance

Before taking up construction, site shall be cleared of all jungles, bushes and unwanted vegetation growth. After completion of plant, the entire site area shall be cleared of all left over material and debris. The work shall be carried out in accordance with the specifications in bill of quantities and payment shall be as per quoted rates for the respective items.

### 12.2. Sections for excavation for all underground structures and pipe lines

Contractor shall prepare sectional drawings showing the details of excavation for all underground structures and pipe lines, in all kinds of soils, boulders, soft and hard rock etc., based on test results of soil testing and investigation reports complying to specifications in clause 2.0 to 2.15 for earthwork excavations and shall submit to the Engineer for review and approval, prior to starting of the work. If during excavation any change in section is considered necessary for reasons of safety of workers, the Engineer will issue directions for compliance by the Contractor. The Contractor shall comply with the Engineer's directions without any extra charge or payment.

**12.3. Form Work**

Formwork, shuttering, centering, scaffolding etc., shall be of steel plates or plywood, lined with MS-sheets and for scaffolding steel tubular shall be used. Joints should be sufficiently tied to prevent loss of cement slurry from the concrete. All forms, shuttering shall be levelled, aligned, and thoroughly cleaned, before they are used for concreting. Formwork shall be removed after specified days of curing with the prior written permission of the Engineer. The surface of RCC after removal of formwork / shuttering shall be smooth and even and without honeycombing or undulations.

**12.4. Procedure and Materials used in concrete works.**

The procedure for concrete works shall be in accordance with the specifications in the bill of quantities, specifications in this section and complying to standard practices in IS:456-2000 with latest amendments, all concrete works shall be executed in accordance with standard practices, including volumetric batching using boxes of standard size, concrete mixers with hopper, compaction using vibrators and according to the directions of the Engineer In-charge of works.

**12.4.1. Aggregates.**

All aggregates, fine and course used in concreting works shall comply to the standards laid down in IS: 456-2000 with latest amendments and specifications in applicable clauses in this section.

**12.4.2. Water.**

The water used in all concreting works shall be of potable quality and tested before usage in the construction works and shall be confirming to IS: 456-2000.

**12.4.3. Cement.**

The cement used shall be of sulphate resisting cement confirming to IS: 12330 as specified and where ever the concrete is coming in contact with sewage. For other concreting works like encasing pipe, pedestals and other structures where there is no contact with sewage, it shall be OPC confirming to IS:8112 with latest amendments and revisions.

### 12.5. Minimum clear cover over Reinforcement

Minimum clear cover over the steel reinforcement shall be 50mm for the members contact with soil/ground water. For other faces the clear cover over the reinforcement shall be as per latest IS Codes.

### 12.6. Tested Steel

Only tested and approved steel shall be used for reinforcement in RCC works, and the Contractor shall produce the test certificates to the Engineer. The type of steel used shall be of TMT of grade of steel Fe: 500 confirming to relevant IS.

### 12.7. Restoration of Storm water drains & other Miscellaneous works.

The storm water drains and cover slabs damaged during execution of works which is not due to the negligence of the contractor as decided by the Engineer shall be restored as per the items in bill of quantities. The specifications in this section are deemed to govern the applicable items in the bill of quantities. All masonry works, concrete works shall be in accordance with relevant IS as mentioned in clause 1.2.6. of this section and or as directed by the Engineer. Other repairs works under heading “Miscellaneous works” in bill of quantities shall be executed in accordance with the specifications and as directed by the Engineer, the finished item of work shall give neat appearance and should serve the intended purpose of the component to the satisfaction of the Engineer.

### 12.8. Disposal of night soil.

The night soil from the existing soak pits shall be cleared and desilted by the bidder including backfilling of the pits to required compaction, handling, salvaging and disposal of night soil /sludge. A suitable site should be identified by the Contractor & approver by the Engineer, for safe disposal of sewage /silt / sludge removed (preferably approved sludge disposal sites of STPs), excavations at the pumping / lifting station sites, which should be away from the water bodies, residential & sensitive areas, agricultural areas and etc. The costs towards removing handling & disposal of night soil / sludge shall be borne by the contractor & is deemed to be included in the quoted offer of the Bidder. If required & certified by the Engineer, sewer cleaning machine will be provided free of cost, for sucking the sewage from soak pit, As soon as the work at the soak pit is completed the pit shall be filled with earth in layers not exceeding 15 cm, each layer shall be watered, rammed & properly consolidated before the succeeding one is laid. Each layer shall be consolidated to the required standard specification. The final backfill surface shall be trimmed & levelled as directed by the Engineer in charge.

## 13.0 TRAINING AFTER COMMISSIONING & DEFECT LIABILITY PERIOD.

### 13.1. Training of Employer's Personnel

The Contractor shall be responsible to provide practical training in all aspects of the operation, maintenance, and facilities to all personnel selected by the

Employer, who will ultimately be responsible for the operation, maintenance and repair of the system and its facilities after defects liability period.

For this purpose, the Contractor shall provide a comprehensive training program for the Employer’s personnel during the entire period of the trial run, and for as long thereafter as may be reasonably required to ensure that the designated personnel are adequately trained to take up their responsibilities.

All costs for the bidder’s personnel and the training facilities required for the training during trial run period, and any incidental training expenses, shall be borne by the contractor.

### 13.2. TRIAL RUN OF THE SYSTEM

After commissioning of works, the contractor shall maintain the works for 3 (three) months to demonstrate satisfactory performance to the Engineer prior to taking over by the Employer. The cost of electricity, if required for operation & maintenance of works during the period of this trial run will be borne by the Employer. The cost towards Contractors Engineer and other operating personnel during the said period of trial run, along with cost of tools and spare parts which are required for operation and maintenance of the works and equipment during the trial run period shall be borne by the Contractor and shall be included in the quoted bid price. In the event that the system or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time as the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements. No additional compensation will be paid to the Contractor for such extension.

### 13.3. DEFECTS LIABILITY PERIOD

During 12 month Defects Liability period, the Contractor has to set right the defects of any kind in the manufacture, laying and jointing of sewer lines and its appurtenants works, other civil and mechanical works in his scope including replacement of defective items, labour and technical services if required and also making good the restored road surface as mentioned above in case of settlement.

Contractor shall be responsible to monitor and ensure the successful performance of the system throughout the Defects Liability Period, and shall be responsible to ensure that the Employer's Personnel are provided with on-the-job training as may be necessary to ensure uninterrupted satisfactory Performance of the system and facilities by the Employer's Personnel after completion of the contract Period.

## 4.0 REINFORCED CEMENT CONCRETE PIPES

### *4.1. Manufacture of pipe*

The RCC pipes to be used for lateral, branch and trunk / outfall sewers shall be of class NP-3, Spigot and Socket (S&S) type, RCC SPUN / VIBRATED

CAST PIPES (REINFORCED), with rubber gasket jointing, manufactured in Conformity with IS 458. All the Pipes shall be manufactured using Sulphate Resisting cement only. The ends of the pipes shall conform to Clause 5.3 of IS 458 as applicable for S&S joints. The rubber ring shall conform to IS 5382 and IS 12820 as applicable for sewer lines and shall be of type 'IA'. The diameters of pipes shall be as required for sewers as per designs and drawings.

The method of manufacture shall be such that the form and dimensions of the finished pipes are accurate within the limits specified in relevant IS: 458. Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

The Internal diameter, wall thickness, length of barrel, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement, strength test requirements, tolerances on - overall length, internal diameter or dimensions of sockets / spigots of pipes shall be as per the relevant clauses / tables of

IS: 458. Minimum clear cover to reinforcement shall be 15 mm. The tolerances regarding overall length, internal diameter of pipes or socket and barrel wall thickness shall be as per relevant clauses of IS: 458. Each pipe unit shall be in lengths of 2 m to 4 m based on availability, ease in handling, transportation and laying.

The workmanship and finish for the pipe will conform to the relevant Indian standard specification; Cleaning of pipes shall conform to relevant Indian Standard specification.

## *4.1.1. Special coating for Inside Surface of RCC Pipes.*

The RCC pipes shall be provided with special coatings wherever there is possibility of excess generation of hydrogen sulphide gas during transportation of sewage through sewers. The location, length of coatings shall be as given in construction drawings or as approved by the Engineer.

The work involves

i). Supply and application of Polymer based protective Elastomeric coating / Lining with zero V.O.C. for complete inside surface of RCC sewers, with minimum dry film thickness of 1mm, Acid resistant, Abrasive resistant, Adhesive to concrete surface, Durable and pinhole / break free, with smooth surface after application, complete as per the Clauses in this Section, including all labour, HOM of machinery, with all lead lifts, taxes etc. complete. spray coating / Lining shall be applied by approved and controlled

mechanical spray method, for RCC sewers of diameters 400mm to 800 mm prior to delivery of sewers to site or applied at site, as approved by approving authority, including all surface preparation, testing, as per directions of the Engineer in charge. Rate shall be inclusive of cost of all materials, tools and plants, testing and inspection etc. complete.

ii) Supply and application / lining of Polyvinyl chloride sheet, having T-shaped protections on the back, keyed into the RCC Sewer walls at the time of manufacture, of thickness not less than 1.5mm or Polymer based protective Elastomeric smooth coating / Lining with zero V.O.C. by spray method for complete inside surface of RCC sewers, with minimum dryfilm thickness of 1mm, Acid resistant, Abrasive resistant, Adhesive to concrete surface, Durable and pinhole / break free, smooth surface after application, complete as per the Clauses in this Section, including all labour, HOM of machinery, with all lead, lifts, taxes etc. complete, spray coating / Lining applied by approved method, for RCC sewers of diameters equal to and greater than 900mm prior to delivery of sewers to site or applied at site, as approved by approving authority, including all surface preparation, testing, and directions of the Engineer in charge, Rate shall be inclusive of cost of all materials, tools and plants, testing and inspection etc. complete.

Specifications for Protective Coating to inside surface of RCC sewers:-

A). POLYMER BASED COATING :

a) The inside of RCC pipes (of dia 400mm & above) & manholes (if required) shall be coated with an approved dual-component, solvent-free polymer protective coating of minimum 1mm dry film thickness. The protective coating shall be spray-applied to the inside of the pipes using suitable plural component spray equipment so as to form a completely impermeable, pin-hole-free & seamless lining. It shall form a good bond with host concrete surface, be resistant to acids & abrasion. It shall meet the following properties.

| A – ACID RESISTANCE | |
|---|---|
| Acid & Chemical Resistance (to ASTM 3908- mod 365d immersion) | Change in weight (not more than). |
| Sulphuric Acid 22% | 0.07% |
| Hydrochloric Acid 10% | 0.07% |
| H2S-120,000ppm (Sour Brine) | 0.66% |
| Sodium Hydroxide 25% | 0.07% |
| Sodium hypochlorite(sat sol) | 0.66% |

| | |
|---|---|
| Salt water – 310g/l (Sat. Sol) | 0.22% |
| Ammonium Hydroxide-20% | nil |
| Nacl/water-solution -10% | nil |
| Wastewater anaerobic digesters | 0.37% |
| Wastewater API mo | 1.1% |
| B – BOND | |
| Bond / Adhesion to concrete (to ASTM D 4541) | > 1.5 N / Sq mm |
| C - ABRASION RESISTANCE | |
| Abrasion resistance (to ASTM D 4060 with Taber CS17-1000/1000rev) | < 15 mg loss |
| Shore D Hardness ( to ASTM D-2240 ) | > 60 |
| D - DURABALITY | |
| Volume solids % | 100 |
| Tear resistance (to Die Cast ASTM D 624 ) | > 30 KN / m |
| Tensile strength ( to ASTM D412) | >17 N / Sq mm |
| Elongation ( to ASTM D-412 ) | > 30% |
| Water absorption( to ASTM D 570 (2hr @95 C) | 0.16 |
| Flash Point (Pensky martin) | >93 deg C |
| E – SETTING TIME | < 1 minute |

b) The coating shall be moisture sensitive,suitable for long term service at any temperature within the range between -10 Deg C and 100 Deg C and resistant to raw sewer, industrial sewer, treated sewer, effluents, chemicals, sea water, abrasives. The coating shall not be affected by high humidity or moisture during application.

c) All the coating materials including primer & finish coats shall be from a single manufacturer of repute certified to ISO 9002 standards having a minimum 10 years experience in similar products & in projects of similar size and value as this project.

d) The material provided shall be tested in both liquid (lab-draw down films) and field applied samples and shall meet the properties specified for the project and defined in the approved manufacturer’s product data sheet.

e) All pre-coating concrete repairs, coating and lining works shall be carried out only by experienced & reputed contractors who are authorized, approved, and certified applicators of the approved coating manufacturer & certified by the manufacturer for the type of application detailed in this project.

f) The contractor should submit, the approved coating manufacturer’s detailed Method Statement for Coating Application along with their Quality Assurance / Inspection & Testing Plan to engineer in charge prior to commencement of coating activity.

Surface Preparation & Primer application

Prior to commencement of coating activity, all concrete surfaces to be coated shall be free from oil, grease, loose particles, decayed matter, moss, curing compound residue or algal growth. All such contamination and laitance must be removed by use of abrasive sweep blasting, high pressure water jetting, or other approved manual/ mechanical means.

Concrete element’s surface irregularities, honeycombs spews must be removed and repaired by a method approved by the engineer.

Primer as recommended by the approved coating manufacturer shall be applied prior to coating application & the correct over coating time intervals shall be followed as per manufacturer’s approved method statement of application.

The coating system shall be spray applied & shall gel/set rapidly. It shall form a uniform monolithic film without any layering.

The pipes shall be coated either at pipe factory or at other department-approved coating yard prior to actual laying.

Testing:-

The finished coating shall be uniform, smooth & have a dry film thickness of minimum 1000 microns, when tested with a standard dft gauge/ Elcometer.

The dry film thickness shall be measured at points as instructed & predetermined by the engineer in charge by fixing SS strips. The coating shall be uniform, smooth & pin hole free.

Personal Safety Requirements:-

The personnel at site shall strictly adhere to Standard guidelines during the chemical coating activity, at all times. The approved coating manufacturer shall supply complete standard requirement schedules for the personnel to follow, prior to start of any coating application. The general requirements are:-

a. Observe the owners standard policy at all times and obey all written and verbal instructions from site managers and representatives.

b. Wear all PPE at all times including Hard Hat, Safety glasses, Boots, Gloves and masks as required.

c. When preparing and applying coatings and chemical materials all PPE must be worn including Gloves, safety glasses and protective paper masks.

d. When using high pressure plural component spray equipment, all personnel working in the application area must wear double filter breathers with OSHA or of atleast equivalent make.

B). P.V.C. LINING FOR RCC PIPES:

Scope of work for PVC lining in RCC pipes,

Reinforced concrete pipes of diameter 900mm and above is to be lined with PVC of minimum thickness of 1.5 mm. The lining shall be fixed to concrete surface be mechanical keys and cover complete internal circumference of the pipes. Care shall be taken to see that the resulting wall thickness, internal diameter & length of barrel does not become less than the minimum specified in IS 458. The tolerances regarding overall length, internal diameter of pipes or socket and spigot wall thickness shall be as per IS: 458. However, due to providing of PVC lining, negative tolerance for internal diameter of pipe upto maximum 3 mm is permitted.

Drawings and details indicating method of manufacture, lining, welding of joints, etc., together with test certificates of physical, chemical and biological properties of the PVC shall be submitted for Engineers in charge’s approval prior to manufacturing of any pipe.

The internal surface (PVC lining and unlined concrete surface) of the pipe shall be free from wrinkles, bulges, corrugations, burnt surfaces and

imperfection. The lining shall be firmly keyed into the concrete with the back face of the lining flush against the concrete surface. The keys shall be continuous and capable of withstanding a back pressure of not less than 0.48 N/ mm2. Partially embedded keys will not be acceptable. There must be complete bonding in all welds.

Only pipes manufactured and lined to the satisfaction of the Engineers in charge are acceptable. Minor defects may be repaired with approval of Engineers – In charge but each defect must be made good to the complete satisfaction of the Engineer in Charge who reserves the right to reject any pipe (or pipes) which in his opinion do not comply with this Specification and the required standard.

Approved PVC lining should not be less than 1.5 mm thickness. In the event of the PVC lining being damaged during the construction of the sewer, the whole pipe shall be replaced entirely at the Contractor’s expense.

When pipes are laid, care shall be taken to keep the cover flaps clear of the adjoining pipe socket and to place the pipe in the correct position so that the PVC sheeting is evenly divided by the vertical pipe centre line.

At regular intervals the Contractor shall arrange for his pipe supplier to visit the site and weld up and test the PVC joint flaps and end cover fillets. Not more than three (3) pipes shall be laid before the joints are welded up.

The Contractor will be required to afford all necessary assistance in keeping the pipes clear of mud and water during the jointing of the PVC flaps.

The Contractor will be required to make arrangements for the supply of water and power and for the proper ventilation of the pipeline during cleaning, tacking and welding and testing of the PVC joints.

On completion of the laying, jointing and welding, the Contractor will be required to carry out a detailed inspection and test of the PVC lining and joint welding in the presence and to the satisfaction of the Engineer in charge.

Physical & chemical properties & testing methods.

TABLE A – PHYSICAL PROPERTIES

| Property | Allowable Standard | | Method |
|---|---|---|---|
| Tensile Strength | Longitudinal | 17.25 Mpa | ASTM D 638 |

| | | | |
|---|---|---|---|
| | Transverse | 17.25 Mpa | |
| Elongation at break | Longitudinal | 225% | ASTM D 638 |
| | Transverse | 225% | |
| Hardness | 54-62 | | Din 535.5 |
| Plasticier Permanence | 0.4% | | ASTM D 1203 |
| Water Absorption | 0.1% | | ASTM D 570 |
| Water soluble matter | 0.05% | | ASTM D570 |
| Porosity | No pin holes | | Spark Tester 7 KV |

TABLE B – CHEMICAL PROPERTIES

| Chemical Agent | Test Method | Change in Weight Not more than |
|---|---|---|
| Sodium Hypo–Chloride 1% | ASTM D 543 (7 days at 20 degree C) | 0.20% |
| Ferric Chloride 1% | | 0.60% |
| Sodium Chloride 5% | | 0.15% |
| Sulphuric Acid 20% | | 0.12% |
| Nitric Acid 1% | | 0.20% |
| Sodium Hydroxide 5% | | 0.10% |
| Ammonium Hydroxide 5% | | 0.40% |
| Soap &Detergent Solution 2% | | 0.40% |

## *4.2. Testing of pipes at manufacturing unit.*

During manufacture, tests on concrete shall be carried out as per IS: 456, IS 458 / relevant IS with latest revisions and amendments.

The specimen of pipes shall be tested in accordance with clause 1.2.8 of this Technical specification and with IS: 458 and tested in accordance with the methods described in IS: 3597 including the following,

1. Hydrostatic test.

2. Three edge bearing test

3. Absorption test.

*4.3. Marking*

Marking shall be done as per IS: 458 or any other relevant IS codes approved by the Engineer. The following information shall be clearly marked on each pipe,

a). Internal diameter of pipe.

b). Class of pipe.

c). Date of manufacture and

d). Name of manufacture or his registered trade-mark or both.

## *a. Carting & Handling*

Carting and handling of RCC pipes and fittings shall be in accordance with the clause 3.4. of GSW pipes specifications.

## b. Trenching.

Trenching includes all excavation which shall be carried out either by hand or by machine and shall be carried out in accordance with all requirements of Earth work excavations clause 2.0 to 2.17. Wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all round the socket in order to make the joint, and the grip shall be maintained clear, until the joint has been approved by Engineer.

## *c. Bedding*

Necessary bedding (granular, concrete cradle, concrete arch etc.) shall be provided in accordance with approved construction drawings and specifications in the following clauses 6.1. to 6.1.5 of this specifications before laying of RCC sewer pipes.

## *d. Laying of the pipe*

Laying of concrete pipes shall conform to the Code of practice of IS: 783. Pipes shall be laid underground with a minimum earth cover of 1m. Pipes shall be generally laid in sections as per standard practices and as directed by the Engineer. The RCC pipes shall be laid with sockets facing up the gradient, on desired bedding. All pipes shall be laid perfectly true, both to line and gradient. At the close of each day's work or at such other times when the pipe is not being laid, the end of the pipe should be protected by a close fitting stopper. All pipes, fittings and material shall be tested and approved by the Engineer before being laid. Any pipes, fittings or material placed before they are tested and approved shall be removed and replaced with tested and approved material. Before laying the pipe, necessary bedding shall be provided wherever required as per Sub-Clauses 6.1. to 6.1.5 of this section.

## *e. Jointing of pipes*

The pipe joints shall be flexible joints, jointed by rubber ring of type 'IA', as per IS 783-1985. The sections of the pipe shall be jointed in such a manner that there shall be as little unevenness as possible along the inside of pipe. Care should be taken while jointing to provide the correct gap between the end of spigot and back of the socket to ensure flexibility at each joint and correct location. The joints shall be finished as directed by the Engineer.The quality of rubber rings, tolerances, etc., shall be in conformity with IS 5382-1985 and latest revisions.After jointing, extraneous material, if any, shall be removed from the inside of the pipe.

## *f. Measurement of pipes*

The length of the sewer pipes shall be measured between the inner surfaces of consecutive manholes at the invert level of the pipes along the central line of pipeline to the nearest centimeter.

## *g. Testing at work site.*

After laying and jointing of pipes is completed, the pipe line shall be tested at work site as per all the requirements in clause 9.0 to 9.5 of this specifications and as approved by the Engineer.

## *h. Backfilling.*

Backfilling shall be in accordance with requirements specified in clause 6.3 to 6.3.4. of backfilling.

# 5.0 DUCTILE IRON (DI) PIPES.

## *5.1. Manufacture of pipe*

DI pipes and fittings (Class K7) shall be in accordance with IS: 8329 and IS: 9523. Pipes and fittings shall be procured from reputed manufacturers with Engineer's approval. Engineer shall at all reasonable times have free access to the place where the Pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing.

All tests specified either in this specification or in the relevant Indian Standards specified above shall be performed by the Manufacturer / Contractor at his own cost and in presence of Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to Engineer

If the test is found unsatisfactory, Engineer may reject any or all pipes and fittings of that lot. The decision of Engineer in this matter shall be final and binding on the Contractor and not subject to any arbitration or appeal. The pipes and fittings shall be striped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects. Any defect in pipes and fittings in the opinion of Engineer shall be rejected and shall be replaced by new one.

In the case of spigot and socket pipes and fittings, the socket shall be without the centre ring. In the case of flanged pipes, the flanges shall be at the right angles to the axis of the pipe and machined on face. The boltholes shall be drilled and located symmetrically off the centreline. The bolthole shall be concentric with the bore and boltholes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

a). Materials

The materials used in the manufacture of pipes and fittings shall comply with requirements specified in IS: 8329 and IS: 9523.

b). Dimensions and Tolerances

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per relevant tables of IS: 8329/IS: 9523 for different class of pipes and fittings. Each pipe shall be of uniform thickness throughout its length.

The tolerances for pipes and fittings regarding dimensions, mass, ovality and deviations from straight line in case of pipes shall be as per IS: 8329/IS: 9523.

*c). Coatings*

i). General

Unless otherwise specified, DI pipes and fittings shall be coated with Bitumen in accordance with relevant IS specifications. All buried DI pipes and fittings shall also have factory or site applied polythene sleeving. Coating shall not be applied to pipe and fittings unless its surface is clean, dry and free from rust. Pipe coatings shall be inspected at site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

ii). Bitumen coating

Bitumen coating shall be of normal thickness of 75 microns unless otherwise specified. It shall be cold applied compound complying with the requirements of relevant Indian standards, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

iii). Polythene Sleeving

Where polythene sleeving is specified to be applied in addition to bitumen coating, it shall comply with ISO 8180. Site applied sleeving shall be stored under cover out of direct sunlight and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions. Joints in the sleeving shall be properly overlapped and taped in accordance with manufacturer's instructions to provide continuous sleeving.

iv). Cement mortar lining

All pipes and fittings shall be internally lined with cement mortar in accordance with relevant IS. The cement used shall be Sulphate Resisting Cement confirming to IS: 12330. No admixtures in the mortar shall be used without the approval of the Engineer.

Pipe linings shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 11906.

## *5.2. Testing of pipes at manufacturing unit.*

During manufacture, tests on pipes shall be carried out in accordance with clause 1.2.8 of this technical specification by the Third party inspecting agency.

*5.3. Marking*

Marking shall be done as per IS: 8329 and IS: 9523 or any other relevant IS codes approved by the Engineer.

The following information shall be clearly marked on each pipe,

a). Internal diameter of pipe.

b). Class of pipe.

c). Date of manufacture and

d). Name of manufacture or his registered trade-mark or both.

## *5.4. Carting & Handling.*

Carting and handling of D.I. pipes and fittings shall be in accordance with the clause 3.4. of GSW pipes specifications.

### a. Trenching.

Trenching includes all excavation which shall be carried out either by hand or by machine and shall be carried out in accordance with all requirements of -Earth work excavations clause 2.0 to 2.17. Wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and

does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all round the socket in order to make the joint, and the grip shall be maintained clear, until the joint has been approved by Engineer.

Wherever D.I. pipes are laid over pillar supports for nala crossings etc. the pipes shall be placed as per the construction drawings and as directed by the Engineer In-charge.

### *b. bedding*

The type of bedding (granular, concrete cradle, concrete arch etc.) shall be as per approved construction drawings and specifications in the following clauses 6.1. to 6.1.5 of this section.

### *c. Laying of the pipe : As above*

### *5.8 Jointing of pipes : As above*

### *5.9 Measurement of pipes*

The length of the sewer pipes shall be measured between the inner surfaces of consecutive manholes or start to end points of laid alignment (at road crossings and Nala Crossings) at the invert level of the pipes along the central line of pipeline to the nearest centimetre.

### *5.10 Testing at work site.*

After laying and jointing of pipes is completed, the pipe line shall be tested at work site as per all the requirements in clause 9.1 to 9.1.4 of technical specifications and as approved by the Engineer.

### *5.11. Backfilling.*

Backfilling shall be in accordance with requirements specified in clause 6.3 to 6.3.4. of backfilling.

## ANCILLARY STRUCTURES – MANHOLES, DROP MANHOLES AND VENTILATING SHAFTS.

The Contractor shall construct Wire cut brick, RCC-Manholes, Drop arrangements with HDPE pipes, Cast iron Ventilating shafts, Valve Chambers, at the locations shown on approved construction drawings, as directed by the Engineer as per the specification in the applicable Indian standards mentioned and as mentioned hereafter. The materials used and construction procedure adopted for the ancillary

structures shall comply to the specifications as mentioned below and clause in standard specifications for civil works

## 7.1. Excavation

Earth work excavations for the Manholes, Drop arrangements and C.I. Ventilating shaft arrangements etc. shall be carried complying to specifications in clause 2.0 to 2.17 and specifications in bill of quantities.

## 7.2. Backfilling.

Backfilling for sewer ancillary structures shall be in accordance with requirements specified in clause 6.3 to 6.3.4 of Backfilling.

## 7.3. Manholes

Manholes shall be built at every change of alignment, gradient or diameter, at the head of all sewers and branches, at every junction of two or more sewers as shown on the drawings complying to IS: 4111 Part1-1967 and latest revisions and as per specifications in this section or as directed by Engineer. Sulphate resisting cement confirming to IS: 12330 shall be used for all the items of works for manholes. The shape of the manholes generally is circular with conical shape at top for Brick manholes, unless specifically stated as on drawings.

The Contractor shall be wholly responsible for giving suitable connections at the junctions of sewer lines with the manholes. The minimum depth of manhole shall be one meter or as in construction drawings or as directed by Engineer.

For House service connections directly to manholes, 110/160mm PVC pipes shall be placed during construction of manholes as per specifications in Clause 8.1.1. and items in BOQ, if the provisional pipes for House service connections are not placed due to the negligence of the contractor, the contractor has to redo the total work of dismantling of manhole shaft and placing of the pipes etc. at his own cost.

The Manholes have been divided into different categories based on depth, diameter and material of construction. Any manholes required to be provided extra, at the locations shown by the Engineer, shall be provided by the Contractor, for which payment shall be made at the quoted rates.

### *7.3.1. Wire cut Brick Manholes.*

7.3.1.1. Construction.

The work shall be executed in accordance with the approved construction drawings and specifications involving,

a). Providing and constructing of 1:3:6 Cement Concrete foundation using approved quality aggregates of 40mm and downsize with an offset of 150mm all round the chamber.

b). Providing and constructing wire cut brick masonry in C.M 1:4 proportion using modular wire cut bricks of class designation 75 of approved quality and confirming to IS : 1077 with a tapering top portion as per approved construction drawings and providing cement mortar plaster in CM 1:3 proportion, 12mm thick inside and outside except for the conical surface outside, where the thickness of plaster shall be 20mm thick.Samples of bricks shall be tested as per IS : 3495 by the Contractor. Bricks rejected by the Engineer shall be removed from the site within 24 hours.Construction of Brick works shall be in accordance with IS 2212:1962 and latest revisions.

c). Providing and constructing benching with Cement Concrete 1:2:4 to the dimensions as on drawings with 1:6 slope in the concrete towards the central drain, plastered with CM 1:3 proportion, 20mm thick and finished with smooth coat of neat cement and fixing of inlet and outlet sewers in the walls with the internal periphery protected with an arch of 1:2:4 Cement Concrete with graded metal of 10mm to 20mm size.

d). Supplying and fixing of, 3 mm thick plastic (as per IS: 10910) encapsulated over 12mm dia. Fe-415 steel (as per IS: 1786) bar footsteps staggered at 300mm apart and providing and fixing of heavy duty circular steel fibre reinforced concrete (SFRC) manhole frame and covers of 560 mm diameter conforming to IS 12592 and the payment for providing of SFRC heavy duty manhole frame and covers shall be paid separately as per quoted rate for the item in bill of quantities.

e). The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

f). The manhole construction work includes curing, pouring tar over MH frame and cover, cost of tar, engraving manhole number and flow direction on the inner surfaces etc., with all lead and lifts, finishing etc complete. The cement used for the construction of masonry works and internal & external plastering works of manholes shall be of sulphate resisting cement only confirming to IS:12330.

7.3.1.2. Testing.

All Brick Manholes shall be tested as per relevant provisions in CPHEEO Manual & relevant IS with latest revisions & amendments and specifications in clause 9.0 of Testing and commissioning.

7.3.1.3. Measurement & payment.

The depth of manhole shall be measured from the top of cover to the invert level of the deepest outgoing sewer from the manhole.The quoted rate for the Manholes for various depths as per the specifications and drawings shall include the cost of sulphate resisting cement, bedding concrete, benching concrete, wire cut brick masonry, plastering, foot steps, fixing SFRC manhole frame with cover, dewatering to keep the manhole dry until final testing etc complete.

The Rates for any fractional variation (increase or decrease) in the depth of the manhole on decimetre basis, shall be paid as per actuals, by adding the difference in rates between the immediately preceding and succeeding depths of such fractional depth of manhole on linear basis.

*For Example: To pay 1.22M depth manhole:*

*Rate for 1M depth Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. X.*

*Rate for 2 M depths Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. Y.*

*Therefore rate for 1.22M depth Manhole*

*= Rs. X + (Y-X)/1.00 x 0.22.*

*Note: For the depths of manholes less than the lowest depths of Bill of Quantities item, the preceding manhole depth shall be taken as zero with zero value to arrive at the rate*

*7.3.2. RCC Manholes.*

7.3.2.1. Construction.

The construction of RCC manholes shall be by Cast In-situ of Circular in shape or approved type Pre-Cast RCC, constructed using form vibrators of standard type, using SRC Cement confirming to IS: 12330. The type of manhole to be constructed shall be as approved by BWSSB, Contractor shall take prior approval for the Design and Process of manufacture of the Pre-cast RCC manholes, the type of vibration for compaction of concrete for pre-cast manholes shall be invariably of form or table vibrator type.

The work of Cast In-situ RCC manholes includes,

a). Providing and constructing of 1:3:6 Cement Concrete foundation using approved quality aggregates of 40mm and downsize with an offset as given in the drawings.

b). Providing and laying granite jelly cement concrete 1:1.5:3 for beds of manholes etc., using 20mm and down size jelly including laying, tamping, etc. for a depth, as per drawings, with water proof compound for top plaster in CM 1:3 curing and smooth finishing for exposed faces with necessary centering and form work etc., complete as per specification, drawing and as directed by the Engineer.

c). Providing and laying cement concrete of 1:1.5:3 proportion for vertical walls using 20mm and down size jelly including laying, tamping, mixing of required quantity of water proof compound for every one bag of cement for plastering in CM 1:3 curing and smooth finishing for exposed faces with necessary centering and form work etc., complete as per specification, drawing and as directed by the Engineer.

d). Providing and constructing benching with Cement Concrete 1:1.5:3 to the dimensions as on drawings with 1:6 slope in the concrete towards the central drain, plastered with CM 1:3 proportion, 20mm thick and finished with smooth coat of neat cement and fixing of inlet and outlet sewers in the walls with the internal periphery protected with an arch of 1:1.5:3 Cement Concrete with graded metal of 10mm to 20mm size.

e). Providing and laying cement concrete of grade 1:1.50:3 proportion with 12mm to 20mm I.S.I gauge of approved gradation hard broken granite/aggregate including cost and conveyance of all materials with wood or steel shuttering form work including machine mixing , centering form work, scaffolding, tamping , vibrating , curing and smooth finish with CM 1:3, 12mm thick for inside surface for RCC Covering Flat Slab with all lead and lifts, etc. complete as per drawing, specification and as directed by the Engineer.

f). Providing, Supplying and fabricating of TMT (Fe-500) reinforcement steel of all sizes, including straightening, cutting, bending, hooking, lapping and/or welding wherever required, placing in position, tieing with binding wire of approved quality and gauge including the cost of binding wire and anchoring to adjoining members wherever necessary including all laps and wastages etc., with all lead and lifts, complete as per design, specification and directed by Engineer.

g). Supplying and fixing of, 3 mm thick plastic (as per IS: 10910) encapsulated over 12mm dia. Fe-415 steel (as per IS: 1786) bar footsteps staggered at 300mm apart and providing and fixing of heavy duty circular steel fibre reinforced concrete (SFRC) manhole frame and

covers of 560 mm diameter conforming to IS 12592 and the payment for providing of SFRC heavy duty manhole frame and covers shall be paid separately as per quoted rate for the item in bill of quantities.

h). The RCC Manhole cost includes all materials, steel, curing, pouring tar over MH frame and cover, cost of tar, engraving manhole number and flow direction on the inner surfaces etc., with all lead and lifts, finishing etc complete. The cement used for the construction of RCC manhole and internal & external plastering works of manholes shall be of sulphate resisting cement only, confirming to IS:12330.

The work of construction of Pre-cast RCC manhole includes,

a). Providing & laying mechanically mixed cement concrete of M-15 grade with stone aggregate (with 20 mm nominal size graded stone aggregate) in benching, Neat cement punning over PCC benching, as given in the drawings.

b). Construction of approved type vibrated Pre-Cast RCC Manhole Chambers constructed using Sulphate resistant Cement & form vibrator of standard type for Circular Manhole Chambers of various internal dia (as indicated in BOQ) at bottom and 0.50 dia at top made up of pre-cast monolithic base, modular riser and top cone in M- 30 grade concrete placed & aligned to provide vertical sides, with O ring rubber gasket at each joint, water tight & adjustment rings over top cone, complete and all connections shall have, a water tight seal between the pipe and the manhole complete as per standard design & drawing.

c). Making connection of drain or sewer line with existing manhole including breaking in to and making good the walls, floors etc. with CC 1:1:5:3. Finishing with CM 1:3 with a floating coat of neat cement and making necessary channels for drain etc. as per specification, drawing and as directed by the Engineer.

d). Providing, Supplying and fabricating of TMT (Fe-500) reinforcement steel of all sizes, including straightening, cutting, bending, hooking, lapping and/or welding wherever required, placing in position, tieing with binding wire of approved quality and gauge including the cost of binding wire and anchoring to adjoining members wherever necessary including all laps and wastages etc., with all lead and lifts, complete as per design, specification and directed by Engineer.

e). Providing MS Foot rests and fixing in manhole with CC Block of 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate of 20 mm nominal size) of size 20x20x10 cm with 20mm square bar foot rest, and providing and fixing of heavy duty circular steel fibre reinforced concrete (SFRC) manhole frame and covers of 560 mm diameter conforming to IS 12592 and the payment for providing of SFRC heavy duty manhole frame and covers shall be paid separately as per quoted rate for the item in bill of quantities.

f). The RCC Manhole cost includes providing danger lighting & use of sight rails & boning roads shoring & strutting wherever required, including sand bedding, watering, curing, cost of all materials, labour, supply & fabrication of steel, pouring tar over MH frame and cover, cost of tar, engraving manhole number and flow direction on the inner surfaces etc., with all lead and lifts, finishing etc complete. The cement used for the construction of RCC manhole and internal & external plastering works of manholes shall be of sulphate resisting cement only, confirming to IS:12330.

7.3.2.2. Testing.

All RCC Manholes shall be tested as in specifications in clause 9.1.3. of Testing of manholes.

7.3.2.3. Measurement & payment.

The depth of manhole both for Cast In-Situ / Pre-Cast RCC manholes shall be measured from the top of cover to the invert level of the deepest outgoing sewer from the manhole. The quoted rate for the Manholes for various depths as per the specifications and drawings shall include the cost of sulphate resisting cement, bedding concrete, benching concrete, RCC floor & roof slab, shaft walls, plastering, foot steps, fixing SFRC manhole frame with cover, dewatering to keep the manhole dry until final testing etc complete.

The Rates for any fractional variation (increase or decrease) in the depth of the manhole on decimetre basis shall be paid as per actuals, by adding the difference in rates between the immediately preceding and succeeding depths of such fractional depth of manhole on linear basis.

*For Example: To pay 1.22M depth manhole:*

*Rate for 1M depth Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. X.*

*Rate for 2 M depths Manhole excluding manhole frame & cover and including encapsulated foot steps rate Rs. Y.*

*Therefore rate for 1.22M depth Manhole*

*= Rs. X + (Y-X)/1.00 x 0.22.*

*Note: For the depths of manholes less than the lowest depths of Bill of Quantities item, the preceding manhole depth shall be taken as zero with zero value to arrive at the rate.*

7.4. Drop Manholes.

In a manhole, wherever the difference between the invert level of downstream sewer and the invert level of the upstream sewer is greater than 60 cm, a drop manhole shall be provided at that position. The locations and construction of the drop manholes shall be provided as on drawings.

HDPE Grade PE-100 pipes confirming to PN 6 as per IS:4984 with latest revisions and amendments suitably supported with MS fasteners at 300 mm c/c. for diameters pipe line as per Bill of Quantities, construction drawings and as directed by Engineer, specials conforming to IS: 1729 shall be used for providing the drop in the manhole & a suitable expander/reducer T-Joint at the top with incoming sewer and 45 degree bend at the bottom with HDPE specials to the direction of flow in the receiving sewer, encasing the pipe with cement concrete of 1:2:4 proportion including necessary centering and form work, vibrating, curing, including cost and conveyance of all materials, labour with all lead and lifts, etc., complete as per specification and as in construction drawing. The benching concrete in the manhole should surround the joint of the terminating bend and a neat channel shall be made in the benching concrete to direct the flow to the receiving sewer. A continuation of the incoming sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with half blank flange as on drawing. The drop manhole arrangements shall be tested along with sewer lines.

7.5. Vent shafts.

CI Vent shafts shall be erected at places as on construction drawings or as directed by Engineer and as per Bill of Quantities. The work includes providing and fixing 150mm diameter, Cast Iron pipe for ventilating shaft of 5 meters high with specials and cowl and with suitable grips in C.C. 1:2:4 pillar using 10mm to 20mm graded hard granite/trap/basalt or any other approved metal with 15 cms thick C.C. around up to 1.22 mtrs above the GL and with a foundation base of 90x90x90 cms plastered with 12 mm thick CM 1:3 to all exposed faces and linking the shaft to the manhole by means of 15 cm dia GSW pipes and specials, jointing with tar dipped hemp 1:1 1/2 CM caulking, curing with all lead and lifts etc., complete for all materials earth work excavation and refilling in all strata, and disposal of surplus earth as directed with all lead and lifts etc. complete.(Sulphate resistant cement shall be used).

9.0. TESTING AND COMMISSIONING.

9.1. Testing at site.

All sewers and appurtenances shall be tested before commissioning and trial run as per the specifications in this section. After laying and jointing of sewer pipes and before backfilling the trenches, the complete length of the sewer is to be checked for water tightness and the sole responsibility of arranging the necessary equipments and apparatus lies with the contractor at his own cost. Any damage during testing shall be contractor's responsibility and shall be rectified by him free of cost. Water for testing shall be arranged by the Contractor at his own cost.

## *9.1.1. Water Test for Sewers.*

After laying and jointing of sewer pipes and before backfilling the trenches, the complete length of the sewer is to be checked for water tightness. Employer may exempt water test for lateral sewers, where house service connections are to be connected immediately to lateral sewers.

The procedure for testing is as detailed below,

Each section of sewer shall be tested for water tightness from manhole to manhole To prevent change in alignment and disturbance after the pipes have been laid, it is desirable to backfill the pipes up to the top keeping at least 90cm length of the pipe open at the joints in case of longer length pipes.

In case of concrete and stoneware pipes with cement mortar joints, pipes shall be tested three days after cement mortar joints have been made. It is necessary that the pipelines are filled with water for about a week before commencing the application of pressure to allow for the absorption by pipe wall.

The sewers are tested by plugging the upper end with a provision for an air outlet pipe with stop cock.. The water is filled through a funnel connected at the lower end provided with a plug. After the air has been expelled through the air outlet, the stop cock is closed and the water level in the funnel is raised to 2.50m above the invert at the upper end. Water level in the funnel is noted after 30 minutes and quantity of water required to restore the original water level in the funnel is determined. The pipeline under pressure is then inspected while the funnel is still in position. There shall not be any leaks in the pipe or the joints (small sweating on the pipe surface is permitted). Anysewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again.

The leakage or quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 lit/mm dia. of pipe per kilometer length per day.

Exfilteration test for detection of leakage shall be carried out at a time when the ground water table is low.

For concrete, R.C.C. pipes of more than 600mm dia. the quantity of water inflow can be increased by 10% for each additional 100mm of pipe dia.

After completion of the test all temporary seals shall be removed, the test water shall be drained out / pumped out and the line cleaned properly.

9.1.2. Test for Straightness and obstruction

As soon as a stretch of sewer is laid and tested, before commissioning the cleanliness of the pipeline is to be checked by the following tests as applicable and as decided by the Engineer.

*a). Torch & Mirror Test*

In this method of testing, a torch will be held one end of the pipeline inside a manhole and its image through the pipeline will be reflected and seen on a mirror held at the opposite end of the pipeline, inside the next manhole. Any obstruction / debris / major mis-alignment will not give a clear image in which case the pipeline will again be cleaned / rectified and the tests re-done.

*b). Ring Test*

In this method of testing two steel/ wooden rings of suitable thickness and design shall be fixed facing each other at a distance of 2 feet or more. The block of rings shall be inserted from one end of the pipeline, inside manhole and pulled by a rope fixed to the block from the other end of the pipeline, inside the next manhole. The rings shall be of dia 75 mm less than the inside diameter of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by suitable means. Any construction / debris / major misalignment will prevent the ring to pass through the pipeline in which case the pipeline will again be cleaned / rectified and the test redone, and no extra payment will be made. Alternately upon the approval of the Engineer, the sewer may be tested by inserting at the high end of the sewer, a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball should roll down the invert of the pipe and emerge at the lower end. Any construction / debris / major misalignment that prevent the ball to pass through the pipeline in which case, the pipeline shall be again cleaned / rectified and the tests redone, and no extra payment will be made.

*9.1.3. Water Test for Manholes.*

The entire height of Brick and RCC manhole shall be tested for water-tightness by closing both the incoming and outgoing ends of the sewers and filling the manhole with water. A drop in water level not more than 50mm per 24 hours shall be permitted. In case of high subsoil water it should be ensured that there is no leakage of ground water into the manhole by observing the manhole for 24 hours after emptying it.

9.1.4. Test Records

Complete test records shall be maintained for all tests carried out for sewers both during construction and after being in service. The tests carried out as in specifications, approved QAP shall be documented in the formats as approved by the Engineer and shall be carried out in the presence of the Engineer or his representative and shall be certified by the Engineer or his representative and the Contractor. All completed Test records/documents shall be submitted to the Engineer before submission of bills.

9.2. Commissioning

After satisfactory completion of works and Testing of the sewer lines and appurtenances as per specifications in above clauses, the system shall be commissioned for trial run and operation.

9.3. Final Finishing

The contractor will ensure that the entire structure along with all its installations is in finished and in new and fully operative condition when handed over. He shall have repaired and removed all signs of damage that might have been done during the course of construction of manholes and laying of sewers. He shall also see that the entire exterior has been finished properly and the entire site is cleared of all extra construction material, debris, and excavated soil. This shall have to be done to the satisfaction of the Engineer.

9.4. As Built Drawings

The contractor shall submit to the Engineer within two months of actual completion of the work, “As Built” Drawings as specified below and operation and maintenance instructions for the whole of the Works. These Drawings shall be accurate and correct in all respects, including the existing sewer network for which the contractor has done the condition assessment survey, shall be submitted to, and approved by the Engineer. Completion Drawings as below on two prints and one polyester film shall be supplied by the contractor, along with a soft copy in CD. These drawings shall be developed in Auto CAD. Drawing shall be of standard size as below,

i). Strip Plans and L-sections of Under Ground Drainage system showing pipe work in package area on scale as per standard practices to the satisfaction of the Engineer, showing sewer alignments, levels, appurtenances, sizes and material of pipe etc. complete.

ii). Structural Drawings showing reinforcement details of all the components covered under this contract as per standard practices.

## 11.2. PRIMING OF BASE COURSE WITH BITUMINOUS PRIMERS

### 11.2.1 Scope

This specification relates to the operation of priming an absorbent base course, preparatory to a subsequent bituminous treatment, through application of a low viscosity bituminous material by spraying. The specification is intended to indicate what is considered to be a good practice for priming and shall apply unless modified by special provisions to take into account any unusual conditions.

The scope involves, Providing and applying primer coat with bitumen emulsion on prepared surface of granular Base of low porosity such as WBM including clearing of road

surface and spraying primer at the rate of 0.75 kg/sqm using mechanical means. As per MORTH specification clause No. 502 complete in all respects with all lead & lifts etc complete.

### 11.2.2 Materials

The bituminous primer to be used should be such that it can penetrate into the base course to perform its intended function.

### 11.2.3. Types of primer

Table 11.2.1 can be used as guidance for choice of primer on different types of surfaces.

Table 11.2.1 Guidelines for choice of primer

| Type of Surface | Emulsion | Cut-back | Road tar |
|---|---|---|---|
| Low porosity | Not | MC-0 | RT-1 or RT-2 |

| | | | | |
|---|---|---|---|---|
| | suitable | | | |
| Medium porosity | SS or MS | MC-1 orSC-1 | MC-2 or SC-2 | RT-2 or RT-3 |
| High porosity | MS | MC-3 or RC-1 | | RT-3 or RT-4 |

The primers shall conform to IS: 8887 – 1978 (for cationic emulsions), IS: 217-1961 (for cut-backs), and IS: 215-1981 (for road tars), as applicable.

11.2.4.Viscosity

For selecting the appropriate type of primer out of the materials indicated in Table 1, the atmospheric temperature during application should be given consideration. Also, within the range of viscosity specified, the primer for use may be selected keeping in view the level of porosity of the surface to be treated.

11.2.5. Quantity of primer

The primer shall be applied at the rate of 0.75 kg/sqm.

11.2.6. Construction

a. Weather and seasonal limitations

Cut-back and road tar primers shall not be applied on wet surface or during dust storm or when the weather is foggy or rainy. Bitumen emulsion can be applied on wet surface. However, emulsions shall not be applied during dust storm or when it is actually raining.

Atmospheric temperature during priming should be above 10° C.

b. Equipment

All equipment required for the execution of work should be in good working condition at site.

c. Preparation of base course surface

The base course surface to be primed shall be swept clean and free from dust. All loose materials and other foreign matter on the surface shall be removed completely, if necessary by using power blowers or sweepers.

Large irregularities, potholes, depressions, etc. shall be repaired prior to priming. Minor depressions may be ignored until the surface is primed.

After which these might be patched with a suitable premixed material prior to the subsequent bituminous treatment.

The underlying surface shall be dry prior to priming. Except that in the case of bitumen emulsions, it may be desirable to dampen the surface slightly in order to obtain better penetration of the primer.

Pre-wetting should be done by water spraying, using equipment capable of uniform application of water over the entire surface. The spraying may be taken up 2 to 12 hours before priming, in such quantity that the surface during priming is damp but not saturated with water. Traffic shall be kept off the prepared areas prior to priming.

d. Application of primer

After the base to be primed has been prepared as described above, the primer shall be uniformly applied over the surface using mechanical sprayers. Rate of application of primer shall correspond to the quantities given in clause 11.2.5.

The spraying should preferably be carried out using sprayer mounted on distributor truck or with hand sprayer using mechanical pump. The use of hand-held containers such as watering cans, perforated buckets etc., is unacceptable and should not be permitted under any circumstances. Quantity should be checked periodically using Tray Coating Test or any other suitable means.

Temperature of application of primer should be high enough to permit the primer to be sprayed effectively through the jets of the spray bar and to cover the base course surface effectively.

e. Curing

The primed surface shall be allowed to cure fully. No traffic shall be allowed over the primed surface during this period and in any case not before 24 hours if the primer is a cut-back bitumen and 6 hours in the case of bitumen emulsion. Any pool of excess cut-back primer, which has not been completely absorbed by any part of the base course surface during the curing period, should be carefully swept over the adjacent surface, and then a light sand blotter course applied. The amount applied should be just sufficient to blot up the excess bitumen and prevent it being picked up under traffic. If an excess of bitumen residue is found on the primed surface after bitumen emulsion has broken, a very light sand dusting may be applied to soak up the surplus material.

All loose sand should be swept from the base course surface prior to any subsequent bituminous treatment.

11.3. Tack Coat

All specifications in the clause 11.2.6 shall apply to this item of work and the specific scope of work involves Providing and applying tack coat with bitumen emulsion using emulsion pressure distributor at the rate of 0.375 kg/sqm on the prepared granular surface cleaned with mechanical broom such as WBM surface as per MORTH specification clause No. 503 complete in all respects with all lead & lifts etc complete for old surfaces at vertical and horizontal joints.

11.4. SPECIFICATIONS FOR SINGLE COAT BITUMINOUS SURFACE DRESSING (20MM THICK PRE-MIX BITUMINOUS SURFACING).

11.4.1. Scope.

This specification is intended to indicate what is considered to be good practice for construction of single coat bituminous surface dressing and shall apply unless modified by special provisions to take into account unusual conditions. The work specified consists of a wearing surface composed of a single application of bituminous material covered with one application of cover material of size as specified below, applied on a previously prepared base or pavement.

The specific scope involves, Providing, laying and rolling of open-graded premix surfacing of 20 mm thickness composed of 13.2 mm to 5.6 mm aggregates either using penetration grade bitumen 80/100 or cut-back or emulsion to required line, grade and level to serve as wearing course on a previously prepared base, including mixing in suitable plant, laying and rolling with a smooth wheeled roller 8-10 tonne capacity, finished to required level and grades. Mechanical method using Penetration grade Bitumen and HMP of appropriate capacity, as per MORTH specification No.511 complete in all respects. (Bitumen 1.46kg/sqmt. Metal = 0.027) with 40-60 TPH hot mix with all lead & lift etc complete.

11.4.2. Materials

a. Bituminous materials - The bituminous materials shall be of grade 80/100 or cut-back conforming to the requirements as specified and provided for in the proposal and satisfy the related specification, issued by the Indian Standards Institution (vide I.S.I Standards 73-1961,215-1961,217-1961 and 454-1961).

b. Cover materials

(i). General requirements - The cover material shall consist of crushed stone, crushed slag crushed gravel (shingle) or other stones, as specified, and shall have clean, strong, durable, and fairly cubical fragments free from disintegrated pieces, salt, alkali, vegetable matter, dust and adherent coatings. The aggregate shall preferably be hydrophobic in nature and of low porosity.

(ii). Physical requirements - The aggregate shall satisfy the requirements given in Table 11.4.1.

Table 11.4.1

| Sl. No. | Property | Value | Method of test |
|---|---|---|---|
| | Abrasion value, using Los Angeles machine or | Max. 35% | IS: 2386 (Part IV) |
| | Aggregate impact value | Max. 30% | - do - |
| | Flakiness index | Max. 25% | IS: 2386 (Part I) |
| | Stripping value | Max. 25% | IS: 6241 |
| | Water absorption (except in case of slag) | Max. 1% | IS: 2386 (Part III) |
| | Soundness: Loss with sodium sulphate – 5 cycles (in case of slag only) | Max. 12% | IS: 2386 (Part V) |
| | Unit weight or bulk density (In case of slag only) | Min. 1120 kg per $m^3$ | IS: 2386 (Part III) |

Where all these conditions cannot be satisfied, it is left to the Engineer-in-charge to allow reasonable tolerances.

Size - The size of chippings to be used shall depend on whether the treatment is for the first coat or for the subsequent or renewal coat and shall be as per the size specified below. For single application of the aggregate, it is desirable to keep the grading of the various sizes as specified in Table 11.4.2.

Table 11.4.2

| | Sieve designation nominal size of aggregate | specification |
|---|---|---|
| | For surfacing water-bound macadam - first coat | 100 percent passing through 20 mm square mesh sieve and retained on 10 mm square mesh sieve |
| | For subsequent or renewal coats 10 mm | 100 percent passing through 12.5 mm square mesh sieve and retained on 6.3 mm square mesh sieve. |
| Note – It is essential to sieve the aggregates through proper size sieves to ensure the size stipulated in the specifications. The sieve sizes indicated above are as per IS: 460 – 1962. | | |

11.4.3. Construction methods

a. Weather and seasonal limitations - Preferably, the surface dressing work shall be carried on only when the atmospheric temperature in shade is 16°C or above. No bituminous material shall normally be applied when the surface or the cover material is damp, when the weather is foggy or rainy or during dust storm, except, in case of emulsions, the surface should be slightly damp.

b. Equipment - All equipment necessary for the proper construction of work shall be on the site of the work in good condition.

c. Preparation of road surface - The underlying course on which surface dressing is to be laid shall be prepared, shaped and conditioned to a uniform grade and section as specified. Any depressions or pot-holes shall be properly made up and thoroughly compacted sufficiently in advance. The defective parts should be clearly cut out and the patches of new material put in, and not put on the existing surface.

Where the existing surface shows signs of "fatting-up", such position should be rectified. It is important that the surface be dry and thoroughly cleaned immediately before applying the binder. The surface should be swept clean free of caked earth and other foreign matter cleaned first with hard brushes, then with softer brushes and finally blowing off with sacks or gunny bags to remove the fine dust. The base shall be applied with Tack coat as per clause 11.4.uniformly preferably by a mechanical sprayer.

d. Application of bituminous material - After the surface to be treated has been prepared, as specified above, bituminous material shall be sprayed uniformly over the dry surface preferably using mechanical sprayers. The binder shall be applied at a temperature appropriate to the type of binder and equipment used. The premix open graded surfacing consisting of aggregates 13.2mm to 5.60mm shall be applied to an uniform thickness as per applicable IS standards to get the final compacted thickness of 20mm.

e. Rolling cover materials - Immediately after the application of the cover materials as described, the entire surface shall be rolled with a 8 to 10 tonne smooth wheeled road roller. The rolling shall begin at the edge and proceed lengthwise, over the-area to be rolled lapping not less than one third of the roller tread and proceed towards the centre. When the centre is reached, the rolling shall then start at the opposite side and again proceed towards the centre. In the super-elevated portions, the rolling should proceed from the inner to the outer edge. While the rolling is in progress, additional aggregate shall be spread by hand in whatever quantities may be required to fill irregularities and to prevent picking up of the aggregate by the roller. Rolling shall be continued until the particles are firmly embedded in the bituminous materials and present a uniform closed surface. Excessive rolling which results in the crushing of the aggregate particles shall be avoided.

f. Finishing - The finished surface shall be uniform and conform to the lines, grades and typical cross sections shown in the specifications.

g. Opening to traffic - When straight run bitumen or road tar is employed as the binder, the finished surface shall be thrown open to traffic on the following day but if in special circumstances, the road is required to be opened to traffic immediately after rolling, speed of the traffic shall be limited to 16 km per hour till the following day.

Where cutback bitumen and emulsion is employed, the finished surface shall be kept closed to the traffic until it has sufficiently cured to hold the cover aggregates in place.

Controlling of traffic shall be done by some suitable device, such as barricading and posting of watchmen, etc.

## 11.5. SEAL COAT.

The scope of work involves Providing and laying seal coat sealing the voids in bituminous surface laid to the specified levels, grade and cross fall using Type A seal coat as per MORTH specification clause No. 513 complete in all respects with all lead & lift etccomplete.(Bitumen = 0.98 kg/sqmt. Metal =0.009).

## 11.6. SPECIFICATIONS FOR CONSTRUCTION OF CONCRETE ROADS

### 11.6.1. Scope

This is intended to indicate what is considered to be good practice for the construction of cement concrete road pavements, including preparation of the subgrade and sub -base underneath these pavements. This does not however cover the requirements of fully mechanized constructions.

The scope involves providing specified thickness of 1:3:6 proportion cement concrete as base course and specified thickness of 1:1.5:3 proportion cement concrete as wearing course as per approved construction drawings and specifications.

### 11.6.2 Materials

a. Ordinary Portland Cement - This should comply with the requirements of IS - 8112 with latest revisions (Specification for Ordinary Portland Cement)

b. Aggregates

General - Aggregates should comply with IS - 383 -1970 "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete (Second Revision)" with special reference to the additional requirements stipulated for use in road works excepting in the case of Los Angeles Abrasion Test limit.

The Los Angeles Abrasion Test limits shall be not more than 35 per cent and 50 per cent for concrete wearing course and sub -base course respectively. ln addition, the limits of deleterious material shall not exceed the requirements set out in IS - 515 -1959 “Specification for Natural and Manufactured Aggregates for Use in Mass Concrete." Weathered rock should not be used. In order to make good concrete, it is important to avoid crushed aggregate of poor shape. Very angular, flaky, elongated or splintery aggregates give a harsh mix of low workability. Maximum size of aggregate should not exceed l/4$^{th}$ of the pavement slab thickness. In case of pavements having reinforcement, maximum size of aggregate should also not exceed l/4th of minimum clear spacing between reinforcing bars.

c. Coarse aggregates

Continuous grading - Continuously graded coarse aggregate should be furnished in at least two separate sizes with separation at 20 mm I.S. sieve when combined material graded from 40 to 4.75 mm is specified, and at 25 mm I.S. sieve when combined material graded from 50 to 4.75 mm is specified.

d. Fine aggregate - Fine aggregate shall preferably be natural sand. Crushed stone sand may also be used satisfactorily in concrete. The fine aggregate shall conform to IS: 383 -1970, the permissible percentage passing limits on 300 and 150 -micron sieves shall be 15 -55 per cent and 0 -20 per cent respectively instead of 15 -50 percent and 0 -15 per cent as stipulated in IS Specification. Crushed sand is usually more angular in shape than naturally occurring sand, and for this reason may tend to make the mix a little harsher. In some cases, it may prove advantageous to use a mixture of naturally occurring sand and crushed stone sand if the former is not obtained in adequate supply or where its grading is poor. Bulking due to presence of moisture in the fine aggregate should be accounted for when volumetric batching is employed.

e. Water - Water used in mixing or curing of concrete shall be clean and free from injurious amounts of oil, salt, acid, vegetable matter or other substances harmful to the finished concrete. It shall meet the requirements stipulated in clauses of IS: 456 -2000 "Code of Practice for Plain and Reinforced Concrete". Potable waters are generally considered satisfactory for mixing or curing.

f. Dowel and tie bars - Dowel and tie bars shall be plain round steel bars conforming to the requirements of IS: 432 -1966.

g. Premolded joint filler – Premolded joint filler shall be of the thickness shown on the drawings within a tolerance of $\pm$1.5 mm. It shall be 25 mm less in depth than the thickness of the slab, within a tolerance of $\pm$3 mm and of the full width between road forms. Holes to accommodate dowel bars shall be accurately bored or punched out. The joint filler shall comply with the requirements of IS: 1838 -1961 "Specification for Preformed Fillers for Expansion Joint in Concrete, Non -extruding and Resilient Type (Bitumen -impregnated Fiber)."

11.6.3. Water content and workability

The water content per batch of concrete should be maintained constantly except for suitable allowances to be made for free moisture and absorption by aggregates determined from time to time during construction. Adjustments for workability shall be made by variations in the ratio of the

coarse to fine aggregate or improving upon their grading without change in cement content or water -cement ratio. The slump of the concrete mix for pavements compacted by vibration should not be more than 25 mm, preferably between 0 and 12 mm, and that by manual compaction not more than 50 mm. No price adjustment would be permissible for variations in the gradations of the aggregates or in the ratio of coarse to fine aggregates necessitated from adjustment at site.

11.6.4. Tools, equipment and appliances

General

All tools, equipment and appliances necessary for proper preparation of sub-grade, laying of sub -base and batching, mixing, placing, finishing and curing of concrete shall be at the project site in good working condition and shall have been inspected by the engineer before the paving operations are permitted to start. Throughout the construction of the project, the construction agency shall maintain all necessary tools, equipment and appliances in first class working condition to ensure proper execution of the work. Arrangements shall also be made for requisite number of stand -by units in the event of break -downs during construction.

11.6.6. Forms

Steel forms - All side forms shall be of mild steel unless use of wooden sections is specially permitted. The steel forms shall be mild steel channel sections of depth equal to the thickness of the pavement. The sections shall have a length of at least 3 m except on curves of less than 45 m radius, where shorter sections may be used. When set to grade and staked in place, the maximum deviation of the top surface of any section from a straight line shall not exceed 3 mm in the vertical plane and 5 mm in the horizontal plane. The method of connection between sections shall be such that the joint formed shall be free from difference in level, play or movement in any direction. The use of bent, twisted or worn -out forms will not be permitted. At least three stake pockets for bracing pins or stakes shall be provided for each 3 m of form and the bracing and support must be ample to prevent springing of the forms under the pressure of concrete or the weight or thrust of machinery operating on the forms.

The supply of forms shall be sufficient to permit their remaining in place for 12 hours after the concrete has been placed, or longer if necessary in the opinion of the engineer.

Wooden forms - Wooden forms may be used only when specifically permitted in the drawing with the exception that their use is herein approved for all curves having radii of less than 45 m. Wooden forms shall be dressed on

one side. They shall have minimum base width of 100 mm for slab thickness up to 200 mm and a minimum base width of 150 mm for slabs over 200 mm thick. Their depth shall be equal to the thickness of the pavement. These forms when used on straight shall have a minimum length of 3 m. Forms shall be held by stakes set at intervals not exceeding 2 m. Two stakes, one on each side, shall be placed at each joint. The forms shall be firmly nailed or secured to the side stakes, and securely braced at joints, where necessary, so that no movement will result from the pressure of the concrete or the impact of the tamper and during finishing work. Wooden forms shall be capped along the inside upper edge with 50 -mm angle iron well recessed and kept flush with the face of the wooden forms.

Setting of forms - The forms shall be jointed neatly and shall be set with exactness to the required grade and alignment. Both before and after the forms are placed and set the sub grade or sub -base under the forms shall be thoroughly tamped in an approved manner. Sufficient rigidity shall be obtained to support the forms in such a position that during the entire operation of compacting and finishing of concrete they shall not at any time deviate more than 3 mm from a straight edge 3 m in length. Forms, which show a variation from the required rigidity or alignment and levels shown in the drawing, shall be reset or removed, as directed. The length and number of stakes shall be such as to maintain the forms at the correct line and grad - e. All forms shall be cleaned and oiled each time before they are used. Forms shall be set for about 200m ahead of the actual placing of concrete.

11.6.7. Joints

General - The location and type of joints shall be as shown in the drawing. The edge of the slab at all joints shall be rounded off with an edging tool having a radius of 6 $\pm$ 1mm. The concrete along the face of all joints and around all tie bars and dowels shall be compacted with an internal vibrator inserted in the concrete and worked along the joint and around all tie bars and dowels to ensure a concrete free from honeycombing.

Types of joints - There are three general types of joints. These are –

(i) Expansion joint - Such joint provides the space into which pavement can expand thus relieving compressive stresses due to expansion and inhibiting any tendency towards buckling of concrete slabs.

(ii) Contraction joint - Such joint relieves tensile stresses in the concrete and prevents formation of irregular cracks due to restraint in free contraction of concrete. Contraction joints also relieve stresses due to warping.

(iii) Warping joint - Such joint relieves stresses due to warping. These are commonly used for longitudinal joints dividing the pavement into lanes.

In addition, construction joints are provided whenever construction operations require them. These are full depth joints and may belong to any of the above types.

All joints shall be carefully installed in accordance with the location and details given on the plans. The details of different types of joints are shown in Appendix B.

11.6.8. Transverse joints

General - Transverse joints can be expansion, contraction or construction joints and shall be placed as indicated on the drawing. They shall make a right angle with the centre line of the pavement and surface of the sub - base/subgrade. Contraction and expansion joints shall be continuous from edge to edge of the pavement through all lanes constructed at the same or different times.

a. Transverse expansion joints - These shall extend over the entire width of the pavement. They shall be of the dimensions and spacing as shown on the construction drawing.

Dowel bars (see Supplementary Note N. 4) as per dimensions, location and spacing shown on the drawing are required at expansion joints to transfer wheel loads to the adjacent slab. For slabs of thickness less than 150 mm no dowel bars may be provided (IS: 6509 -1972). The pre-moulded expansion joint filler, a compressible material used to fill the gap between adjacent slabs at expansion joint shall conform to IS: 1838 -1961.

The height of the filler board shall be such that its top is 25 mm below the surface of the pavement. The dowel bars shall be held accurately in position during the placement, compaction and finishing of concrete at and near the expansion joint. This and the protection of the joint groove during construction may be achieved by means of sufficiently strong bulkheads (as per IRC: 43 -1972) with holes drilled along the centre line to accommodate the dowel bars and a mild steel section (as per IRC - 43 -1972) respectively. The latter shall be oiled or greased before placing in position to avoid bonding with concrete. The top and bottom edges of the bulkheads and mild steel section shall be shaped to correspond to the camber of the pavement at the joint. If considered convenient, two -piece split bulkheads may also be used. When dowel bars are provided, bulkheads shall be used in pairs, one at the joint location, and the other some distance away to hold the projecting ends of the dowel bars to maintain their alignment. For cases where dowel bars are not provided, one single bulkhead without holes will be adequate.

The bulkheads shall be securely staked in place at right angles to the

centre line and surface of the pavement with sufficient stakes to hold them in the specified position.

After the concrete has sufficiently hardened the mild steel metal section shall be removed carefully without disturbing the edges. The edges shall then be rounded with an edging tool. For facilitating removal of the mild steel section as well as edging operation, the top of the section may be flared on both sides with the required curvature of a rounded edge.

Under no circumstances shall any concrete be left above the expansion 'joint filler or across the joint at any point. Any concrete spanning the ends of the joint next to the forms shall be carefully cut away after the forms are removed.

b. Transverse contraction joints - These shall be placed as shown on the drawing and shall be of the weakened plane or "dummy" groove type. They shall be constructed by forming in the surface of the slab a slot not less than 6 mm wide and having a depth equal to one -third to one -fourth the depth of the pavement at the thinnest part of its section. This slot may be formed in a manner approved by the engineer such as by pushing into the concrete a flat bar or the web of a "T" bar using a suitable vibratory device, removing the bar, and keeping the slot open. It shall be ensured that no spalling of concrete occurs while removing the bar. The edges of the joint shall be rounded with an edging tool before the concrete hardens.

c. Transverse construction joints - These shall be placed whenever placing of concrete is suspended for more than 30 minutes. Excepting in the case of emergency, construction shall always be suspended at the regular site of expansion or contraction joints. If the construction joint is located at the site of an expansion joint, regular expansion joint shall be provided; if at the site of a contraction joint or otherwise, the construction joint shall be of butt type with dowels.

At all construction joints, bulkhead shall be used to retain the concrete and care shall be taken in striking off and finishing the surface to the top face of the bulkhead. When work is resumed, the surface of concrete laid subsequently, shall conform to the grade and cross -section of previously laid pavement, and a straight edge 3m in length shall be used parallel to the centre line, to check any deviation in the surface of the two sections. Any deviation from the general surface in excess of 3 mm shall be corrected.

11.6.9. Longitudinal joints

These shall be of the plain butt type and shall be formed by placing the concrete against the face of the slab concreted earlier. The face of the slab concreted earlier, shall be painted with bitumen before placing of fresh

concrete.

Tie bars shall be used at longitudinal joints and they shall be of the dimensions and at spacing shown in the construction drawing. Tie bars shall be supported so as not to be displaced during construction operations. Tie bars shall be bonded in the slabs across longitudinal joints, and whilst casting the first slabs, they may be bent so that one end of them lies along the forms. After removal of the forms, bars shall be straightened so that they extend into the concrete placed on the other side of the joint.

11.6.10. Construction

a. Storage and handling of cement

Cement shall not be stored for a long time and should be used normally within six months of its date of receipt. Even during this period of storage it is essential that cement shall be protected from moisture by storing it in suitable sheds. Storage shed with a concrete floor laid on a well -drained foundation may be satisfactory. Cement in bags shall be stored on boards raised above the floor level for the purpose of ventilation, and the bags shall not touch the walls of the shed. Different consignments should be separately stacked and used in order in which they have been received. When bulk supply cement is used, special storage facilities such as covered hopper bins will be required. Supply of cement should be co-coordinated with its consumption so that it is not stored right through the rainy season, when normally concreting is discontinued. Cement having lumps which have been caused due to improper storage or by pressure due to over -loading of bags shall not be considered for use unless these lumps can be easily powdered with pressure between fingers. Before such cement is used, representative sample containing also the lumps in fair proportion shall be taken and tested as per IS - 269 -1976, 8112 -1976, 1489 -1976, 455 -1967 or 8041E -1976 as the case my be, to fulfill the minimum requirements.

b. Storage and handling of aggregates

The location and preparation of sites, minimum size of stack and the methods adopted for dumping and stacking to prevent segregation of coarse and fine material shall be subject to the approval of the engineer. Aggregates from different sources and/or of different grading shall not be stacked together. Each separate size of coarse aggregate shall be stacked separately. The storing of aggregates upon the carriageway or shoulders shall not be permitted.

If aggregates are stored in conical stacks, segregation will be increased by the rolling of the coarser particles down the sides of the stacks. To avoid this, stacks should be built up in approximately horizontal layers.

Dry fine aggregate segregates and gets blown away easily it may be helpful to moisten it. To assist in controlling the water/cement ratio, large fluctuations in the moisture content of aggregates may be reduced by storing the bulk of the material well in advance of use. For this purpose, all washed aggregates shall be stacked for draining at least 12 hours before being batched. It is also a good practice to reserve the bottom 150 -300 mm or so of the stacks as a drainage layer. Where this cannot be done, the aggregates should not be placed on the ground. In such case, somewhat raised planks, metal sheets or concrete base should be provided and laid to slopes.

The aggregates shall be handled from the stacks and fed into the mixer in such a manner as to secure the stipulated grading of the material. Aggregates that have become mixed with earth or other foreign material shall not be used. They shall be washed clean before use.

c. Batching of materials

All batching of materials shall be by weight or volume as approved by the Engineer. the proportion of ingredients shall be as specified in the item of work in Bill of Quantities, The Engineer may permit the use of fractional bags of cement provided they are accurately weighed and are handled in a manner meeting with his approval. Water may be measured by volume. It should, however, be borne in mind that weigh batching is definitely much more desirable than volume batching. If batching by volume is permitted, as a special case, separate measuring boxes shall be provided for the different aggregates. The boxes shall be of strong construction provided with handles for convenient lifting and loading into the mixer. They shall be of such size that it should be possible to measure out the requisite quantity of aggregate per batch in whole box or by multiples thereof and capable of being lifted by two men. Each box shall be provided with a straight edge of required length for striking off after filling. If so directed by the engineer, improved facilities such as tipping boxes of accurate capacity working on run -out rails arranged for direct delivery into the hopper of the mixer shall be provided by the construction agency. In volume batching, suitable allowance shall be made for the hulking of fine aggregate due to the presence of water. For this purpose the bulking shall be determined as per relevant Indian Standard Specification.

d. Mixing

General - The mixing of concrete shall be done in a batch mixer of approved type, which will ensure a uniform distribution of materials throughout the mass, so that the mix is uniform in colour and homogeneous. All concrete

shall be mixed in quantities for immediate use.

The mixer shall be equipped with approved water -measuring device capable of accurate measurement of water required per batch. The mixer shall preferably be equipped with a mechanically operated pump for filling the mixer tank.

The mixer, if so specified, shall be equipped with an approved timing device which will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period; the device shall also be equipped with a ball, adjusted to ring each time the lock is released. If the timing device gets broken, the mixer will be permitted to be used while the same is being repaired, provided an approved time -piece equipped with minute and second bands is provided. Each batch shall be mixed for at least one and a half minutes. Spilling of the materials at either end of the mixer shall be corrected by reducing the size of the batch and in no case shall the volume of the mixed material per batch exceed the manufacturers guaranteed capacity of the mixer. The type, size and number of mixers shall be so chosen as to provide the required output without overloading. The mixing speed of the drum shall not be less than 15 revolutions per minute nor the peripheral speed of the drum greater than 60 m per minute. The batch of cement, fine aggregate and coarse aggregate shall be fed into the mixer simultaneously with the water being introduced either at the same time or before the dry materials. The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

The skip shall be so maintained and operated that each batch will be completely discharged into the mixing drum at the loading of the mixer. The mixer shall be cleaned at suitable intervals while in use.

Pick -up and throw -over blades in the drum of the miner which are worn down 20 mm or more in depth shall be replaced with new blades.

(i). Time of mixing - The mixing of each batch will continue not less than one and half minute after all the materials are discharged into the mixer.

(ii). Re-tempering - The re-tempering of concrete i.e. remixing with or without additional cement, aggregate or water shall not be permitted.

11.6.11. Control of workability and strength

a. Workability of concrete - The workability of concrete shall be checked by performing "slump test" or "compacting factor test" in accordance with IS ; 1199 -1959 “Method of Sampling and Analysis of Concrete." The frequency of testing shall be one test per 10 m3 of concrete and the permissible tolerances from the specified value for workability shall be -

| | |
|---|---|
| Slump | ± 12 mm |
| Compacting factor | ± 0.03 |

Where variations beyond the permitted tolerances are observed, necessary adjustment shall be made keeping the water cement ratio same.

b. Strength of concrete - The strength of concrete shall be determined either by compressive or flexural strength tests (preferably the latter, since concrete pavements are designed on the basis of flexural strength of concrete) depending on the facilities available. For this purpose, during the progress of the work, cube/beam samples shall be cast for testing at 7 and 28 days. Sampling and testing shall be done in accordance with IS - 1199 - 1959 “Method of Sampling and Analysis of Concrete" and IS - 516 -1959 "Method of Test for Strength of Concrete" respectively. The minimum frequency of samples shall be 3 cube/beam samples for each age of 7 and 28 days for every 30 m3 of concrete.

On a paving job, the strength of concrete should be continuously monitored to ensure that the desired strength is achieved. In certain -cases, because of change in the source of cement or control or climatic factors, the strength may show some variations, which would require re -designing of the mix.

11.6.12. Transporting and placing of concrete - The concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub - base to the required depth and width of the pavement section, in successive batches and in continuous operation without the use of intermediate forms or bulk -heads between joints. Care shall be taken to see that no segregation of materials results whilst the concrete is being transported from the mixer to the place where it is deposited. The usual method of transport of concrete in India is in pans as head loads or in small wheel barrows. The spreading shall be as uniform as possible to avoid re-handling of the concrete. Where, however, a certain amount of re -distribution is necessary, it shall be done with shovels and not with rakes. While being placed, the concrete shall be tamped with suitable tools for slab thicknesses of 12.5 cm and less so that formation of voids or honeycomb pockets is prevented. The concrete shall be particularly well placed and tapped against the forms and along all joints, For higher thicknesses an internal vibrator shall be employed in lieu of rodding of the concrete. To effect adequate compaction, the concrete shall be placed with appropriate surcharge over the final slab thickness. The amount of surcharge will depend on the mode of placement of concrete and shall be determined by trial. In general, the required surcharge is about 20 per cent of the required slab thickness. Any portion of the batch of concrete that becomes segregated while depositing it on sub-grade shall be

thoroughly mixed with the main body of the batch during the process of spreading. In case of unavoidable interruption, a full depth transverse joint shall be made at the point of stoppage of work provided the section on which the work has been suspended is about 2 to 3 hours long. In placing of concrete for two course construction, necessitated by either positioning of the reinforcement, a richer mix for the wearing surface, or when thickness of the concrete is beyond 20 cm, the bottom layer of concrete shall be struck off to the required levels by a vibrating screed working on the side forms with notches corresponding to the depth of the top course of concrete.

The vibrating screed should have a vibrating unit mounted on it similar to that of the screed used for compaction of the final surface of concrete. The time lag between laying of the two courses shall not exceed the initial setting time of cement.

11.6.13. Placement of steel

a. Reinforcement - Reinforcing steel shall be free from dirt, scale or other foreign matter and rust of such degree or development as to impair bond of the steel with the concrete. The width of fabric sheets or bar mats shall be such that when properly placed into the work the extreme longitudinal bars or wires of the sheets or mats will be located not less than 50 mm and not more than 100 mm from the edges of the slab. Except for dummy joints, the length of fabric sheets or bar mats shall be such that when properly placed into the work, the reinforcement will be clear of transverse joints by not less than 50 mm and not more than 100 mm as measured from the centre of the Joint to the ends of longitudinal bars or wires of the sheet or mat.

While overlapping the sheets or mats in either direction, the overlap shall be at least equal to the spacing between the bars or wires in the respective direction or 40 times the diameter of the bar or wire, whichever is more.

Whilst using reinforcement in one layer, the concrete shall be placed in two stages. The initial layer shall be uniformly struck off to a depth corresponding to the reinforcement shown in the drawings and lightly compacted by a screed to obtain uniform levels. The reinforcing fabric sheet or bar mat shall then be placed on the compacted layer of concrete and remaining depth shall be filled in with concrete thereafter.

In doing this operation, the initial layer of concrete shall be struck off to the entire width of the slabs and of sufficient length to permit sheet or mat of reinforcement to be laid full length without further manipulations of the reinforcement. Displacement of the reinforcement during concreting operations shall be prevented.

b. Load transfer devices - dowels - Transverse expansion joints shall be equipped with dowels of the dimension and at the spacing and location indicated on the drawing. They shall be firmly supported in place, accurately aligned parallel to the sub-grade/sub -base, parallel to each other and parallel to the centre line of the pavement, by means of appropriate dowel supports. The dowel supports shall ensure that the dowels are not displaced during construction. The permissible tolerances in dowel bar alignment in both vertical and horizontal directions shall be ±1 mm in 100 mm for dowels of 20 mm and smaller diameters and ±0.5 mm in 100 mm for. dowels of diameter greater than 20 mm. One -half of each dowel shall be painted with a thin film of bitumen and equipped with a tight fitting metal sleeve of the dimensions shown on the drawing to provide space for the dowel when pavement expands and the join closes. This sleeve shall be partly filled with cotton waste to prevent it being pushed too far on the dowel during construction.

These sleeves are not required on dowels, if used, in dummy contraction or construction joints.

c. Tie bars - Tie bars provided in longitudinal joints of plain butt type to prevent opening of such joints shall be bonded to the adjacent slabs on both sides of the longitudinal joint. They are installed by providing appropriate (drilled) holes in the side forms depending on the size and spacing of bars. They are bent aside temporarily to avoid obstruction to construction traffic and straightened later at the time of laying of slab in the adjacent lane.

11.6.14. Compaction and finishing

11.6.14.1 Compaction - The pavement shall be compacted either by means of a power-driven pavers-cum -finisher or by a vibrating screed along with internal vibrators where the slab thickness is more than 12.5 cm. For lesser thicknesses vibrating screed may be supplemented with manual rodding. For areas where the width of the slab is very small as at the corner of street junctions, etc. compaction with wooden hand tampers may be adopted subject to the approval of the engineer. In no case, however, hand compaction shall be permitted for slab thicknesses beyond 10 cm. All compaction shall be done in accordance with the following requirements –

(i) Where hand tamping is permitted as a special case –

(i) Concrete with surcharge, as soon as placed, shall be struck off uniformly and screeded, to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross -section indicated by the plans. The entire surface shall then be tamped and the tamping operation continued until a close knit dense surface is obtained.

(ii) The tamper shall rest on the side forms and shall be drawn ahead with a sawing motion, in combination with a series of lifts and drops alternating with lateral shifts, the aim of this operation being compaction and screeding to the approximate level required. Subsequent tamping should advance about 75 mm at a time in the direction in which the work is proceeding, and in the final stages tamping should be closer, about 12 mm at a time until a level and dense surface is obtained.

(iii) Segregated particles of coarse aggregate which collect in front of the tamper or screed shall be thrown outside the forms or thoroughly mixed by hand with the un compacted mass of concrete already placed. Under no circumstances shall such segregate particles be carried forward and pushed on to the base in front of the mass.

(iv) Compaction by tamping or screeding shall be carried on till the mortar in the mix just works up to the surface. Care shall be exercised and the operation of tamping so controlled as to prevent an excess of mortar and water from being worked on to the top. Repeated operation other than to secure the necessary compaction and to eliminate voids shall be avoided.

(v) Immediately after the tamping or screeding has been completed and before the concrete has hardened, While the concrete is still in a plastic stage, the surface shall be inspected for irregularities with a profile checking template and any needed correction made by adding or removing concrete followed by further compaction and finishing.

11.6.14.2. Floating - As soon as practicable after the concrete has been compacted, its surface shall be smoothened by means of a longitudinal float, operated from a foot -bridge. The longitudinal float shall be worked with a sawing motion, while held in a floating position parallel to the carriageway centre line and passed gradually from one side of the pavement to the other. Movements ahead along the centre line of the carriageway shall be in successive advances of not more than one half the length of the float.

11.6.14.3. Straight-edging - After the longitudinal floating has been completed and excess water has disappeared, but while the concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. The straight edge shall be held in successive positions parallel to the road centre line in contact with the surface and the whole area gone over from one side of the slab to the other. Advance along the road shall be in successive stages of not more than one -half length of the straight edge. Any area of depression found shall be scooped to a depth of 4 -5 cm, filled immediately with freshly mixed concrete, struck, compacted, and re-finished. High areas shall be cut down and refinished. The straight edging and re-floating shall continue until the entire surface is found to be free from

observable departures from the straight edge and the slab has the required grade and camber.

The slab surface shall be retested for trueness, before the concrete begins to set, with the 3 m long master straight edge and the graduated wedge gauge.

The straight edge shall be placed on the surface in successive positions, parallel to the carriageway centre line. Irregularities shall be measured with the help of the wedge gauge moved transversely at various points until it touches both the straight edge and the concrete surface.

At any point tested the concrete shall not show a departure greater than 3 mm from the true surface. If at any place the departure exceeds this value not more than 3 passes of the vibrating screed shall be allowed and the surface tested again in the specified manner. If the irregularity still exceeds the limit aforesaid, the concrete shall be removed to a depth of 50 mm or up to the top surface of the reinforcement, if any. The area of concrete to be removed shall be demarcated by the length of the straight edge in the position of measurement across the full width of the slab. Where the point of measurement in default is less than 4.5m from the nearest transverse expansion joint, the whole area upto the joint shall be removed to the required depth. The concrete so removed shall not be re -used in the carriageway. Fresh concrete shall be placed, compacted and finished in the manner already described in these specifications and shall again be subject to testfor accuracy of finish.

The foregoing procedure shall be adopted at each shifting of the straight edge and the whole area shall be gone over from one side of the slab to the other. The straight edge shall advance longitudinally in successive stages of not more than one -half the length of the straight edge.

No extra payment shall be made for the removal of the rejected concrete and or laying fresh concrete.

Although the concrete may be removed immediately following measurement of the irregularity and while it is still wet, this shall not mean any waiver from complying with the requirements of this clause, if for any reason the concrete to be removed has already hardened.

After straight edging of the surface, it shall be finished by brooming in the manner described as mentioned in the following paragraphs.

11.6.14.4. Brooming - After belting and as soon as surplus water if any has risen to the surface, the pavement shall be given a broom finish with an approved long handled steel or fiber broom conforming to the stipulations

laid down in JRC - 43 -1972. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be' perpendicular to the centre line of the pavement and so executed that the corrugations thus produced will be uniform in character and width, and about 5mm deep. Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions and small pockets, such as may be caused by accidentally disturbing the particles of coarse aggregate embedded near the surface.

11.6.15. Curing of concrete - Immediately after the finishing operations have been completed the entire surface of the newly laid concrete shall be covered against rapid drying, and cured. Failure to provide sufficient cover material of the stipulated type or inadequate supplies of water for curing shall be adequate cause for immediate suspension of concreting operations.

11.6.15.1. Initial curing - After completion of the finishing operations, the surface of the pavement shall be entirely covered with wet hessian cloth, burlap or jute mats. The coverings used shall be of such length (or width) that when laid will extend at least 500 mm beyond the edges of the slab, shall be so placed that the entire surface and both the edges of the slab are completely covered. They shall be placed as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to their being placed, the coverings shall be thoroughly wetted with water and placed with the wettest side down. They shall be so weighed down as to cause them to remain in intimate contact with the surface covered. They shall be maintained fully wetted and in position for 24 hours after the concrete has been placed, or until the concrete is sufficiently hard to be walked upon without suffering any damage. To maintain the coverings wet, water shall be gently sprayed so as to avoid damage to the fresh concrete. If it becomes necessary to remove the coverings for any reason, the concrete slab shall not be kept exposed for a period of more than half an hour.

Worn coverings or coverings with holes shall not be permitted. Coverings reclaimed from previous use other than curing concrete shall be thoroughly washed prior to use 'for curing purposes, if the covering is furnished in strips, the strips shall be laid to overlap at least 150 mm.

Covering shall be placed from suitable wooden bridges (IRC -43 - 1972). Walking on freshly laid concrete to facilitate placing coverings shall not be permitted.

11.6.15.2. Final curing - Upon the removal of the covering the slab shall be thoroughly wetted and then cured by one of the following methods of final

curing -

(a) Curing with wet earth - Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal dykes of clay about 50 mm high, covered with a blanket of sandy soil free from stones to prevent the drying up and cracking of clay. The rest of the slab shall then be covered with sufficient sandy soil so as to produce a blanket of earth not less than 40 mm depth after wetting. The earth covering shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 14 days and thoroughly wetted down during the morning of the 15th day and shall thereafter remain in place until the concrete has attained the required strength and permission is given to open the pavement to traffic. When such permission is granted, the covering shall be removed and the pavement swept clean. If the earth covering becomes displaced during the curing period, it shall be replaced to the original depth and re -saturated,

11.6.16. Removing forms - Forms shall not be removed from freshly placed concrete until it has set, or at least 12 hours, whichever is later. They shall be carefully removed in such a manner that no damage is done to the edges of the pavement. After the forms have been removed, the slab edges shall be cleaned and any limited honey -combed areas pointed up with 1 -2 cement sand mortar, after which the sides of the slab shall be covered with earth to the level of the top of the slab for final curing Slabs with excessive honey -combing as a result of inadequate compaction shall be removed between nearest transverse joints.

11.6.17. Concreting during monsoon months - When concrete is being placed during monsoon months and when it may be expected to rain, sufficient supply of tarpaulins or other waterproof cloth shall be provided along the line of work. Any time when it rains, all freshly laid concrete, which has not been covered for curing purposes, shall be adequately protected by means of tarpaulins or other waterproof cloth. Any concrete damaged by rain shall be removed and replaced.

11.6.18. Concreting in hot weather - As placing of concrete in air temperatures above 40°C, or above 35°C combined with relative humidity below 25 percent and/or wind velocity higher than 10 km/hour, is attended with defects like loss of workability through accelerated setting, formation of plastic shrinkage cracks, etc., it is recommended that unless adequate precautions are taken, no concreting shall be done in conditions more severe than the above. The procedures recommended for adoption in case of hot weather concreting is given in IRC - 61 -1976 “Tentative Guidelines for the Construction of Cement Concrete Pavements in Hot Weather." Brief details of the procedure are given below -Aggregates, cement and water shall be

protected from the direct sun and mixing operations shall also be carried out in shade. In addition portable shelters shall be provided to protect the concrete during placing and finishing operations. This may be in the form of gable frames to cover the full length of the concrete pavement laid in a day. The surfaces of the formwork and subgrade coming in contact with concrete shall be moistened prior to placing of the concrete to prevent absorption of mixing water.

Since the setting time of concrete is considerably reduced under such temperatures, labour force shall be reinforced to minimise the time between mixing and placing of concrete. The protective cover shall be adequate to exclude exposure of the concrete directly to the sun and also eliminate contact with drying winds. Prior to removal of the portable shelters, the hardened concrete shall be covered with wet hessian or burlap or the like followed by one of the usual methods of curing like ponding, etc. In addition, the moist curing period shall be extended to 4 weeks.

11.6.19. Work on gradients - The progress on gradient of all operations of placing, compacting and finishing of concrete should proceed from the lower to the higher reaches. The concrete mix shall be stiffer than that used on level reaches.

11.6.20. Protection of concrete - Suitable barricades shall be erected and maintained and watchmen employed to exclude traffic from the newly constructed pavement for the period herein prescribed, and these barriers shall be so arranged as not in any way to interfere with or impede traffic on any lane intended to be kept open and necessary signs and lights shall be maintained clearly indicating any lanes open to the traffic. Where, as shown on the plans or indicated in the special provisions, it is necessary to provide for traffic across the pavement, suitable and substantial crossings to bridge over the concrete shall have to be provided. Such crossings, as constructed, shall be adequate for the traffic and approved by the Engineer.

Any part of the pavement damaged by traffic or other causes occurring prior to its final acceptance shall be repaired or replaced in a manner satisfactory to the Engineer. The pavement shall be protected against all traffic usage including that of construction -traffic.

11.6.21. Sealing of joints - After the curing period is over and before the pavement is opened to traffic, the temporary seal and all other intruded materials in the transverse expansion and contraction joints as well as longitudinal joints shall be removed completely and the groove; filled with the approved joint sealing compound as per IRC - 57 -1974 "Recommended Practice for Sealing of Joints in Concrete Pavements”. The joint opening shall be thoroughly cleared of all foreign matter before the primer followed by

sealing material is placed. If necessary, the foreign matter shall be blown out by compressed air pressure. All contact faces of the joint shall be cleaned with a wire brush to remove loose material and shall be surface dried before the primer is applied.

11.6.22. Opening to traffic - In general, traffic shall be excluded from the newly constructed pavement for a period of 28 days where Ordinary Portland Cement, Portland Blast Furnace Slag Cement and Portland Pozzolona Cement are used, or for a period of 7 days where Rapid Hardening Cement is used. In all cases, before the pavement is opened to traffic it shall be cleaned and the joints shall be sealed